Sign production by first-time hearing signers: A closer look at handshape accuracy

Produção de gestos por ouvintes gestuantes iniciados: um olhar atento para a orientação manual

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Abstract

This paper presents phonetic analysis of hand configurations elicited from hearing adults exposed for the first time to signs in American Sign Language. The accuracy of their production is analyzed in terms of various handshape sub-features, including degree of finger splay and opposition of the thumb. Two familiar factors from spoken second language acquisition, markedness and phonological transfer, are proposed as plausible factors affecting subjects' handshape accuracy. Although these conclusions are preliminary, based only on a limited data sample, they indicate promising directions for further study of hearing adults learning a sign language as a second language. Research attention in this area stands to greatly deaf children and their parents, the vast majority of whom are hearing and need to become proficient in sign language as efficiently as possible.

Keywords: *sign language; language development; deafness; linguistics* ⏮

Resumo

Este artigo apresenta a crítica das configurações manuais elicitadas de adultos ouvintes expostas pela primeira vez à Língua Gestual. O rigor de sua produção pode ser analizado em termos das subestruturas que suportam a orientação manual, incluindo a abertura dos dedos e a oposição do polegar. Dois factores familiares na aquisição de línguas orais, enquanto L2 – a marcaçãoe a transferência fonológica são factores plausíveis de afectação do rigor da orientação manual nos sujeitos. Apesar de estas conclusões serem preliminares e baseadas, apenas, em dados de amostragem, elas indicam difecções prometedoras para a estudo de adultos ouvintes que tentem a língua gestual como sua L2. A investigação nesta área é necessária tendo em conta a maioria de pais ouvintes com filhos surdos cuja necessidade de proficiência em Língua Gestudal é mandatória.

Palavras Chave: Língua Gestual – Desenvoltura de Linguagem, Surdez, Linguística ⏮

Introduction

This paper discusses methodological issues related to research on the acquisition of natural sign language[1]. Although sign acquisition has received much research attention over the past half century, nearly all of that research has focused on very young deaf and hearing children or (less frequently) deaf adults who were not permitted to learn sign language until puberty or beyond, leading to late acquisition of their first language. The study discussed in the current paper is unusual in that focuses on an entirely new case of language learning, that of hearing adults learning a natural sign language as a second language. This aspect of sign language acquisition has been severely understudied, despite its clear potential for improving deaf children's chances for normal linguistic development.

At first glance, it seems improbable that studies of hearing adults learning sign language as a second language should have any relevance for linguistic development of deaf children. Extensive research on the transmission of natural sign languages within deaf, signing families has demonstrated repeatedly that when deaf children are exposed to sufficiently rich input in a natural sign language, they acquire

[1] Natural sign languages such as American Sign Language (ASL) or Língua Gestual Portuguesa (LGP) have evolved over time within deaf communities and have rich lexical and grammatical structures independent from the spoken languages that surround them. They are not to be confused with artificial sign systems such as Signed Exact English (SEE) or Signed Portuguese. The latter systems were invented by educators for the purpose of teaching spoken language and are not naturally transmitted from deaf parent to deaf child in the way that natural sign languages are.

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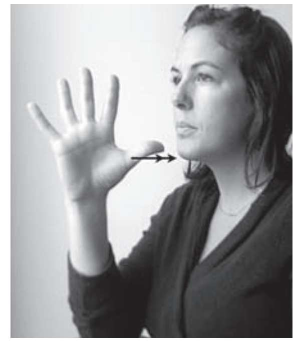
a first sign language in a manner that is comparable to first language acquisition of speech by hearing children. The question remains, however, as to how native-like sign language input must be in order to qualify as "sufficiently rich." The vast majority of deaf children (about 95% in the US, according to Mitchell et al. 2006) are born to hearing parents who are unlikely to know a natural sign language such ASL or Lengua Gestual Portuguesa (LGP). Therein lies the value of research on sign acquisition as a second language. Although some of these parents commit to learning sign language, aware of the enormous benefits of sign language exposure to early linguistic development and later academic achievement (Mayberry and Eichen 1991; Wilbur 2005), they have limited pedagogical resources at their disposal, which hinders their progress. As first-time adult learners of a sign language, these parents have to cope not only with difficulties typical of second language acquisition in general (e.g. transfer or interference from the first language), but also difficulties specific to learning language in a new modality (manual/visual versus oral/aural). A better understanding of how second-language and second-modality (M2 for short) factors interact is key to maximizing the speed with which hearing parents can become proficient in natural language and provide their deaf children with the early input critical to their linguistic development.

This paper discusses results of a small pilot project focused on one very narrow aspect of M2 acquisition of sign language, handshape accuracy. For readers unfamiliar with sign linguistics, a Background section is provided, providing basic information about sign phonological structure and summarizing previous work on phonological acquisition in sign language first and second language acquisition. This paper also addresses a fundamental methodological issue raised by these previous studies: the importance of a consistent phonetic notation system for sign languages.

Background

Signs can be described in terms of four basic phonetic parameters: hand configuration (sometimes referred to as handshape[2]), location, movement,

Image 1 – ASL sign for MOTHER



and palm orientation. For example, the ASL sign for MOTHER in Image 1 consists of repeated contact (movement) at the chin (location) of the 5 handshape[3] oriented with the palm facing the contralateral side of the signer's body. While small variations in parameter values are common across different signers, forms that deviate too far from the standard in one or more parameters are judged by native signers to be ill-formed and may not be understood. For instance, shifting the location of the ASL sign MOTHER up a few centimetres to the upper lip renders the sign meaningless. Accurate production of the phonetic parameters of signs is thus an important goal for new learners of sign language.

Markedness and transfer

For new signers, much like for new learners of spoken languages, a variety of factors may prevent accurate phonetic production. One is L1 (first language) transfer, or the tendency of substituting a phonetic form in the learner's existing L1 phonetic inventory for a phonetic form from the new language, due to the mistaken perception that the two are interchangeable. Another factor affecting accurate phonetic production for second language learners is markedness, or variability in the relative ease with which certain phonetic units are recognized and reproduced. Unmarked forms generally occur more frequently, are more easily perceived and are easier to articulate than marked forms.

The concepts of markedness and transfer are familiar from studies of second language acquisition of spoken languages (Jakobson 1968), but they are also

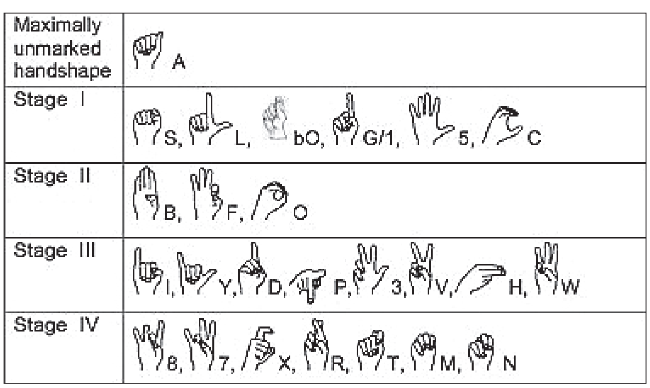
[2] Although *handshape* and *hand configuration* have often been used interchangeably, I follow Johnson (2008) and his colleagues in distinguishing between the two terms. I will use *hand configuration* to refer to actual instances of production by a given individual, while *handshape* will refer to the abstract label (based on the ASL manual alphabet and number system) traditionally used to group similar-looking hand configurations into convenient categories. Thus an individual asked to reproduce a list of signs targeting the Y *handshape* may produce multiple distinct *hand configurations*.

[3] For a list of common ASL handshapes, the reader is directed to Image 2, appearing later in this paper.

applicable to L1 and M2 acquisition of sign languages. Boyes Braem (1973, 1990) made the earliest proposal for an anatomically-informed hierarchy of handshape markedness for ASL. She observed that the fingers of the hand are successively bound by ligaments into several autonomous and semi-autonomous bundles, such that certain combinations of fingers are more difficult to manipulate than others. The thumb and index are the most independent of digits, and as such are easy to manipulate individually. In contrast, the ring, middle and pinky fingers are bound together by a ligament, making them difficult to manipulate independently. From these anatomical observations, Boyes Braem predicted that handshapes involving independent manipulation of the thumb or index (eg. the 1 handshape) are less marked than handshapes requiring individual manipulation of the remaining fingers (eg. the 3 handshape).

In addition to purely anatomical factors for markedness, Boyes Braem proposed secondary factors that potentially increase articulatory complexity, such as crossing or insertion of fingers (for handshapes R or T and N, respectively), or opposition of the thumb (eg. in handshapes S and 1). Taken together, these factors predict a hierarchy of handshape complexity that Boyes Braem divided into 4 stages (plus A as the maximally unmarked handshape), listed below.

Image 2 – Boyes Braem (1973/1990) hierarchy of handshape markedness



Maximally unmarked handshape	A
Stage I	S, L, bO, G/1, 5, C
Stage II	B, F, O
Stage III	I, Y, D, P, 3, V, H, W
Stage IV	8, 7, X, R, T, M, N

ASL handshape font courtesy of http://www.lapiakdesign.com/lapiakasl.html

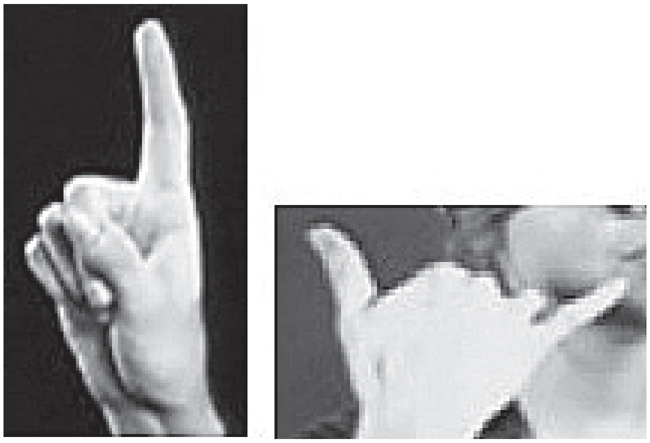
The predictions of the Boyes Braem hierarchy have been tested on naturalistic output by young children acquiring ASL as their L1 and have generally been found to be consistent with patterns of handshape acquisition and substitution: unmarked handshapes are not only produced earlier than marked handshapes, they are also commonly substituted for the latter (Boyes Braem 1990 and McIntire 1977). Given these effects in L1 signing, it is reasonable to suppose that markedness may exert similar effects on M2 signing. Two recent studies of M2 sign phonology, Rosen (2004) and Chen Pichler (to appear), differed in their portrayal of markedness as a factor in M2 handshape accuracy. Rosen (2004) maintained that adult learners have fully developed motor skills and are less unlikely to struggle with the anatomical demands of marked handshapes as young children do. However, Chen Pichler (to appear) argued that a fully developed motor system does not guarantee flawless motor skills in new physical domains (also noted by Mirus et al. 2001). Thus adult M2 learners may be susceptible to markedness effects, particularly in the beginning of their sign language development.

Unlike markedness, which is often assumed to apply universally, regardless of the learner's L1 and L2, phonological transfer is a language-specific phenomenon. Transfer is said to be *positive* when a learner correctly perceives a target form as being identical to a form in his or her L1. The learner can then transfer that form into the L2 without having to learn it. On the other hand, transfer is said to be *negative* when the learner fails to perceive a difference between the target form in the L2 and a similar (but not identical) form in the L1. In this case, the learner fails to establish a new phonetic category for the new form, instead assimilating it to an existing form in the L1. Thus persistent foreign accent, perhaps contrary to intuition, stems more from mispronunciation of target forms that are *highly similar* to familiar forms in L1, than from forms that are completely foreign to the learner (Best 1995; Flege 1995).

Once a phonetic form is recognized by the learner as new, its acquisition is predicted to take place according to the normal developmental path, subject to universal developmental factors such as markedness (Major 2001). Chen Pichler (to appear) argued, contra Rosen (2004), that transfer also exerts an effect on M2 sign acquisition, despite disparate modalities of the L1 and L2. This is because the source for phonological transfer in these cases lies not in the spoken L1, but in the system of conventionalized gestures (e.g. emblems) commonly used in hearing communities. Image 3 shows two conventionalized gestures that are widely used and understood across the American hearing community.

Although they do not qualify as formal phonetic analyses of the handshapes employed by conventionalized gestures, popular "guides to American gesture" such as Axtell (1997) and Armstrong and Wagner (2003) employ a set of plain-English han-

Image 3 – American conventionalized gestures "call me" (on the left) and "wait a minute" (on the right)



dshape labels in their descriptions, such as *fist* or *point* or *V-shape*. This practice suggests that such handshapes are reasonably similar and identifiable across users. Many of these handshapes look identical or similar to those found in ASL, raising the possibility that new ASL learners might transfer them to their M2 signing[4]. For instance, returning to Image 3 presented earlier, the "call me" gesture utilizes a hand configuration that is potentially conflatable with the ASL Y handshape. Although Y is categorized as marked under the Boyes Braem hierarchy, new signers confronted with this handshape in ASL signs may nonetheless reproduce it accurately, due to the fact that they have experience using it in the conventional gesture "call me." In this way, proposes Chen Pichler (to appear), markedness and transfer may exert opposing effects on the second language development of handshape.

Importance of a phonetic notation system for sign

Although studies of handshape development are relatively common in the sign language literature, particularly with respect to first language development, comparability between these studies is hindered by the lack of a standardized way to notate details of sign form. Unlike spoken languages, for which linguists can represent phonetic forms with considerable detail using the Intenational Phonetic Alphabet (IPA), there is currently no widely available notational system to represent the phonetic distinctions of signed forms. Most studies (including Chen Pichler, to appear) use the traditional labels introduced by Stokoe et al. (1965) in the first ASL dictionary to refer to whole handshapes. These labels are based on the manual alphabet and number system in ASL (e.g. Y, F, 1, 3), with additional labels for configurations that do not correspond to any letter or number (e.g. open-8 or b(aby)-O). While referring to "the Y handshape" or "the 1 handshape" is convenient for informal discussion, such global designations are grossly inadequate as a substitute for a phonetic notation system. Small but potentially contrastive differences go unrepresented and potentially distinct hand configurations are lumped together in a single category. For instance, although the two forms in Image 4 differ noticeably in the degree of abduction of the thumb and pinky, both are designated as the Y handshape.

Image 4 – Two variations of the Y handshape

call me WRONG

We still know little about the distribution of these two configurations in ASL or other sign languages, or the extent to which they are interchangeable. Yet we cannot begin to address such questions using notational systems that conflate the two forms.

Sign notation systems that represent signs by specifying the values for each of their four parameters rather than a global designation are a marked improvements over the traditional handshape labeling system, and have been available since Stokoe et al. (1965). Notation systems proposed by (Prillwitz et al. 1989) and Liddell and Johnson (1989) can capture a far greater level of phonetic detail than previous systems and have been adopted by more recent studies of sign phonological acquisition (eg. Takkinen 2002). The latest and most comprehensive notation system to be proposed, Johnson (2008), allows sign forms to be represented in overwhelming detail. While such a system may strike one as overly exhaustive in its descriptive power, it is precisely this feature that permits researchers the means to finally determine what level of phonetic detail is contrastive in natural sign languages and important for language acquisition.

[4] This possibility is based on the assumption that nonsigners recognize handshape as a discrete subunit of gestures at some level.

Material and Methods

Goals of the study

There are two goals of the current study. The main goal is to look for effects of handshape markedness and handshape transfer in the phonological production of first-time M2 signers. This goal is expressed by two null hypotheses: (a) subjects production of unmarked handshapes will be more accurate than their production of marked handshapes, and (b) subjects will substitute (transfer) a handshape from conventional gesture for a target sign handshape whenever the subject's gestural rendition of that handshape is identical to the target sign handshape. In cases where the subject's gestural rendition of the handshape is in fact not similar but not identical to the target sign handshape, such transfer will result in an error (negative transfer).

The second goal of the current study is to compare the patterns that emerge from a traditional whole-handshape label system compared to highly detailed phonetic notation system. The majority of the data, previously reported in Chen Pichler (to appear), were coded using the traditional global-labeling system plus minor modifications to specify features such as thumb opposition and finger abduction. The current report includes a comparison of the previously reported analysis with a new analysis based on partial recoding of the data using the Johnson (2008) notation system, probing the extent to which coding practices influence the generalizations that emerge in data analysis.

Subjects and stimuli

Subjects for this pilot project were four hearing, nonsigning adults (two male and two female) with no previous experience learning a sign language. These adults were not technically ASL learners, since they were not enrolled in an ASL class. Age of exposure to a second language, the environment in which it is learned, the type and amount of exposure the learner receives, the attitude and motivation he/she brings to the task, etc. all affect development. The net result of these factors is that even within the same classroom, individual students can progress at vastly different rates. By testing subjects with no previous experience with sign languages, this study aimed to mimic the very initial stage of acquisition, before learner variability becomes too pronounced. Also, since this experiment constituted subjects' first and only input to ASL, this allowed a higher degree of control over subjects' exposure to the target language than would have been possible if they had been enrolled in an ASL class.

Stimuli included five common American gestures and 16 signs from ASL, representing the handshapes S, 1, B-dot, Y, W, and open-8 (the full list of stimuli is given in Appendix A at the end of this report). According to the Boyes Braem hierarchy, both marked handshapes (2/5 gestures and 7/16 signs) and unmarked handshapes (3/5 gestures and 9/16 signs) were represented. Among the stimuli were also signs with handshapes potentially identical or very similar to handshapes used in conventional gesture (14/16 signs), and signs with handshapes distinct from any used in gestures (2/16 signs). To minimize confounding effects of phonological complexity in the other parameters, only signs with relatively unmarked location (either chest, chin or neutral space) and movement (mostly simple contact movements or a shake/trill) were selected, and no more than a single handshape throughout the sign was allowed (i.e. signs with sequences of multiple handshapes were excluded). The resulting 16 ASL signs and 5 conventionalized gestures were presented in random order, in two trials. The signs were modeled by a native signer from a deaf, signing family, filmed from two angles to give as clear a view of each sign as possible. Subjects saw each stimulus three times: first from head-on, then from the side, and finally from head-on again, before being given three seconds to copy the stimulus. Subjects were instructed to try to reproduce each item as faithfully as they could, focusing on the hands.

All subject production was videotaped and coded for handshape accuracy. A reproduced sign hand configuration was coded as accurate if it was the same as that used by the model in terms of handshape category (identified by the traditional global labeling system) and any of the following features that were applicable: thumb opposition (fully opposed, partially opposed or unopposed) position of unselected fingers (open or closed), degree of splay (adduction or abduction) of extended fingers (hyper splayed, fully splayed, splayed or unsplayed), and relative position of thumb and pinky when in contact (pinky pinned under thumb, pinky and thumb tips pressed against each other, thumb resting against side of pinky). These criteria were also used for coding subjects' gestures, although these were not categorized as accurate or inaccurate, on the assumption that subjects would likely produce their customary forms for familiar gestures rather than faithfully imitating the model.

The production of subject 4 was subsequently recoded in more detail, using notation from the Johnson (2008) system to specify multiple features concerning extension/flexion of the thumb and each finger, adduction/abduction of the four fingers, thumb opposition and abduction, and thumb-finger contact. Appendix B at the end of this report lists the possible values for each feature and their notational symbols as proposed by Johnson (2008).

Results

Image 5 below presents a visual summary of subject's percent accuracy in reproducing the six target handshapes under discussion in this chapter. For this initial analysis, a token could only be counted as accurate or inaccurate; tokens in which some aspect of the produced hand configuration matched the target, but others did not, were classified as inaccurate. In other words, hand configurations were evaluated as whole units, following typical practice in previous studies of handshape acquisition.

The handshapes in Image 5 are grouped visually by shading pattern: unmarked handshapes (S, 1, B-dot) are represented in solid shading, while marked handshapes (Y, W, open-8) appear in patterned shading (checkered or striped). An absent bar represents a 0% accuracy rate for that particular handshape.

Evaluating accuracy on the level of whole hand configurations, subject 4 scored very high for target handshapes Y and W; her production matched that of the target 100% of the time (8/8 and 4/4, respectively) for finger/thumb splay and thumb opposition. In contrast, subject 4 scored quite low for target handshapes S (1/8), 1 (2/6), B-dot (2/10) and open-8 (1/4).

Subject 9 performed at high accuracy for target handshapes 1 (100% or 6/6) and B-dot (90% or 9/10). He was moderately accurate for target handshapes S (63% or 5/8), Y (63% or 5/8) and open-8 (50% or 2/4). All of his production of target W was coded as inaccurate (0% or 0/4) because his pinky was consistently pinned beneath his thumb, a configuration that contrasted with the target forms.

Subject 10 was highly accurate in his production of the target S handshape (100% or 8/8) and moderately accurate in his production of target 1 (67% or 4/6) and B-dot (60% or 6/10). He was less accurate for target handshape Y (25% or 2/8), due to the fact that his pinky and thumb were splayed further apart than the model for these signs. His production for both the open-8 handshape and the W handshape were all coded as inaccurate (0% or 0/4 in each case). Like subject 9, his main error in production of target W involved the relative placement of the thumb and pinky.

Finally, subject 12 was moderately accurate in her production of five out of the six target handshapes: S (50% or 4/8), 1 (83% or 5/6), B-dot (70% or 7/10), Y (75% or 6/8) and open-8 (50% or 2/4). The only handshape she did not produce accurately was target W (0% or 0/4), for largely the same reason

Image 5 – Table 2: Handshape accuracy in elicited signs

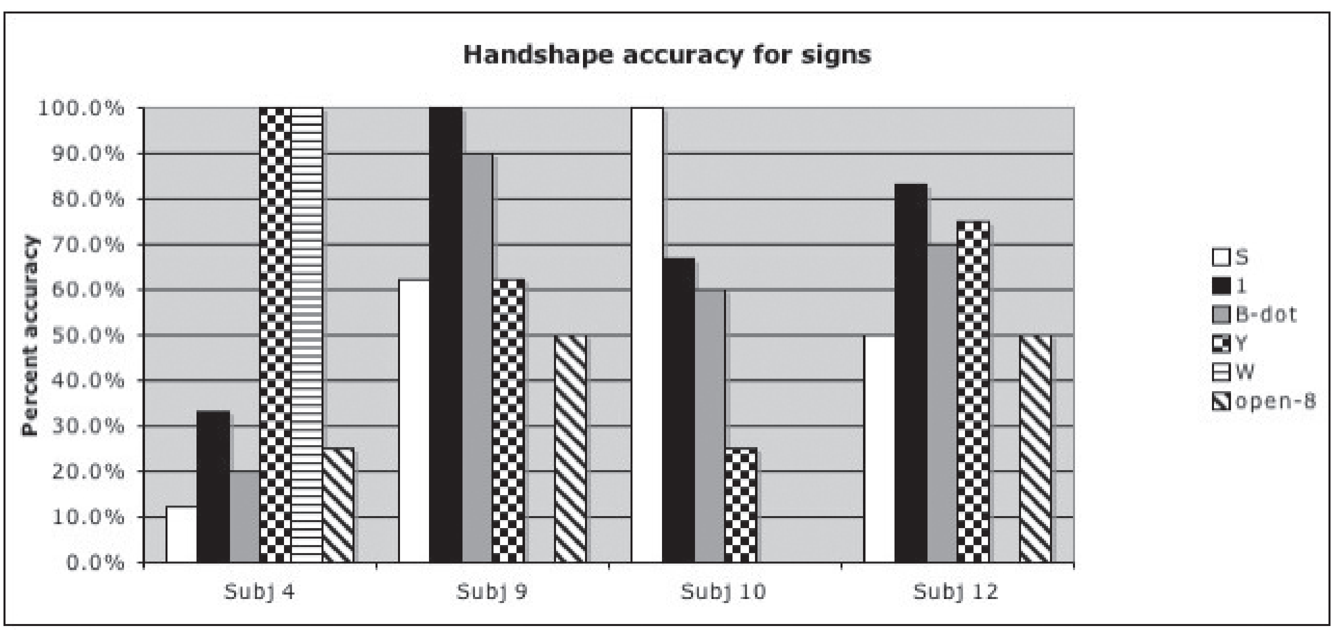


Image 6 – Errors with target open-8 handshape: FEEL

Target Subject 4 Subject 10 Subject 12

Errors with target W handshape: SIX-YEARS-OLD

Target Subject 9 Subject 10 Subject 12

as subjects 9 and 10 (inaccurate relative placement of the thumb and pinky, or contact between the thumb and ring finger).

Discussion

Handshape accuracy for elicited signs: Effects of markedness

The prediction for this study with respect to markedness was that all else being equal, subjects would reproduce unmarked handshapes more accurately than marked handshapes. Applied at the level of overall performance for each subject, this prediction appears to be true only for subject 9, whose production was overall more accurate for unmarked handshapes than for marked handshapes. This was not the case for any of the other subjects, least of all for subject 4, whose performance was overall more accurate for marked than unmarked handshapes.

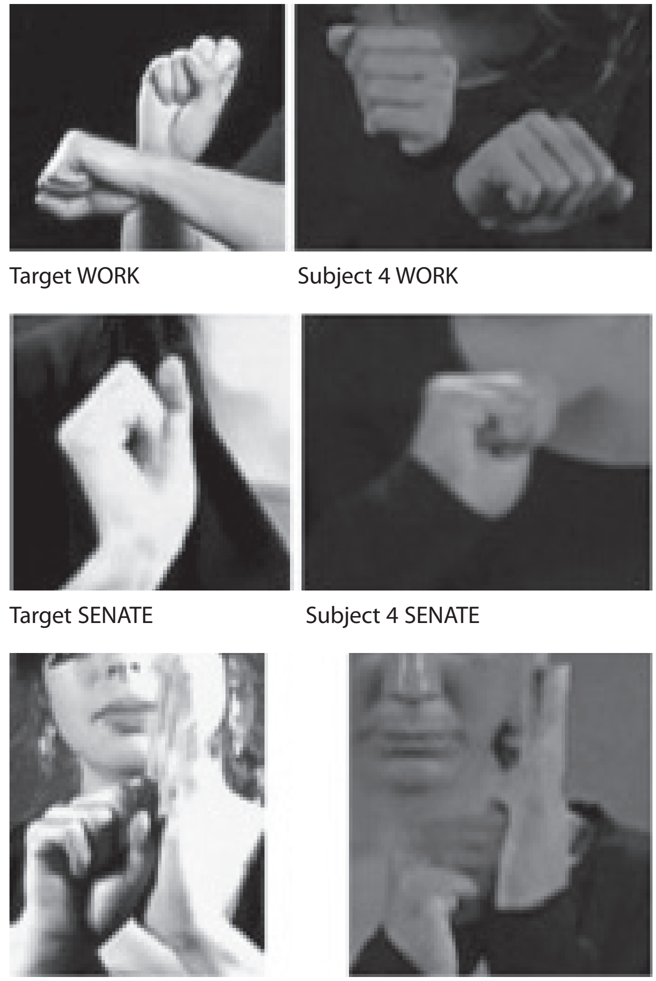
However, examination of the data with respect to specific handshapes rather than pooling overall performance reveals plentiful evidence that markedness should still be considered as an influential factor affecting M2 handshape accuracy. For instance, all subjects but subject 4 were able to reproduce unmarked 1 and B-dot handshapes 60% or more of the time. Conversely, highly marked handshapes W and open-8 posed serious problems for all subjects. With the exception of subject 4, none of the subjects correctly reproduced the W handshape in any of the sign stimuli (0/4 items). As for open-8, subjects 9 and 12 reproduced the handshape accurately in half of the sign stimuli (2/4 items), subject 4 in a quarter of the stimuli (1/4 items) and subject 10 in none of the stimuli (0/4 items). The examples below illustrate the errors with target handshapes open-8 and W, respectively. For each example, the target stimulus viewed by the subjects appears furthest to the left.

The open-8 handshape is predicted to be very marked by the Boyes Braem hierarchy and to my knowledge does not occur in any conventionalized American gesture. It is thus unfamiliar to the subjects and predicted to be acquired according to normal developmental patterns, i.e. subject to universal factors such as markedness. Errors with this handshape generally involved placement of the nonselected fingers (thumb, index, ring finger and pinky). Errors with the W handshape, in contrast, were due to relative placement of the pinky and thumb. For instance, subjects 9, 10 and 12 produced instances of this handshape with the nail of the pinky pinned under the thumb, rather than touching pad-to-pad with the thumb. Although this appears to be a handshape variant permitted in ASL, it was coded as an error, since it did not match the handshape in the stimulus that these subjects received. In the case of subject 10, errors with target W may also be explained by transfer, to be discussed in the next subsection.

Subjects also made many substitutions of a less marked handshape for one that is more marked. For instance, subjects 4 and 9 substituted the A handshape for target S in the sign SENATE. S is considered by Boyes Braem (1973/1990) to be more marked than A because it requires opposition of the thumb, a secondary feature she claims increases handshape complexity. Since these substitutions are made in the direction of less marked forms, such errors are still compatible with the prediction that markedness exerts a negative influence on accuracy. In the case of subject 4, her particular pattern of substitution could alternatively be analyzed as the result of transfer, as I will detail in the next subsection.

Finally, subject 4 was highly successful with marked handshapes W and Y, reproducing them accurately in 100% of the sign stimuli. This result is unexpected, from the viewpoint of the Boyes Braem (1973/1990) hierarchy. One feature that the W and Y handshapes have in common, in contrast to the open-8 handshape, which subject 4 reproduced poorly, is that the index, middle and ring fingers shared the same configuration (i.e. all open or all closed). These three fingers are not bound together in the same way that, for instance, the middle, ring and pinky fingers are. Thus a strictly anatomical/production explanation fails to account for this particular accuracy pattern. Instead, the movement of the inside three fingers as a single block, in opposition to the pinky and thumb, may have improved the perceptual saliency of W and Y for subject 4, leading to successful reproduction.

Image 7 – Subject 4 errors in S handshape



Target WORK — Subject 4 WORK

Target SENATE — Subject 4 SENATE

Target SYMBOL — Subject 4 SYMBOL

Handshape accuracy for elicited signs: Effects of transfer

The second prediction for this pilot study was that subjects would accurately reproduce handshapes that are identical to a handshape they use for a conventional gesture (positive transfer), but commit transfer errors for target handshape that are very similar but not identical to a handshape they use for conventional gesture (negative transfer). In the original Chen Pichler (to appear) analysis, two handshapes were categorized as “very similar but not identical” if they differed only in one of the features used to determine accuracy of handshape reproduction. Of the handshapes analyzed here, only open-8 has no similar gestural counterpart. The other five handshapes are all similar or identical to handshapes found among common American gestures (see Appendix B) and are thus potential sources for transfer.

Transfer can be posited in cases where subjects produced a nontarget sign handshape that matched a handshape they also used in gesture. Our data include several such cases of such negative transfer, almost all involving unmarked handshapes S and 1. Subject 4 substituted a fist with unopposed or partially opposed thumbs for the target S handshape (fully opposed thumb) in several signs (WORK, SENATE, SYMBOL), as illustrated in the examples below.

As mentioned in the previous sub-section, markedness might be a factor in this substitution pattern, since the S handshape is considered to be slightly more marked than the A handshape. However, markedness alone does not provide a satisfying explanation for these errors. Both A and S handshapes lie at the unmarked extreme of the markedness hierarchy, which should render both of them relatively easy to execute, especially for adults

Image 8 – Subject 4's production of the S handshape in gesture

Target gesture *Yes!*

Subject 4 gesture *Yes!* (trial 1)

Subject 4 gesture *Yes!* (trial 2)

with fully developed motor abilities. More likely, some other factor has led subject 4 to perceive the S handshape incorrectly as the A handshape in these stimuli.

Close examination of subject 4's production of the gesture *Yes!* (two fists raised in the air in victory) provides a possible explanation for her handshape errors described above. While the model produced this gesture with two S handshapes, subject 4 reproduced it with unopposed or partially opposed thumbs, as illustrated below. This makes a compelling case for negative transfer, since the same nontarget handshape occurs across both gesture and sign stimuli targeting the S handshape.

I propose that subject 4's handshape inventory includes a handshape that we can call the *fist* handshape. When she sees signs or gestures with the A and S handshapes, she perceptually assimilates them (Best 1995) to the *fist* category she already possesses. This leads her to reproduce signs targeting the A and S handshapes with her particular version of the *fist* handshape, which involves an unopposed or partially opposed thumb. For signs targeting the A handshape, this transfer results in

Image 9 – Subject 4's production of the A handshape

Target ATHLETE

Subject 4 ATHLETE

accurate reproduction (at least with respect to thumb position), as seen in the sign ATHLETE below. For signs targeting the S handshape, transfer results in an error, despite the highly unmarked status of the S handshape.

A negative transfer account is also plausible for errors in subject 4's production of the target handshape 1.The sign stimulus WHERE requires full thumb opposition, but was reproduced by subject 4 in both trials with an unopposed thumb. Subsequent analysis reveals that this subject's gesture for *wait a minute* was also produced with the unopposed thumb version of the 1 handshape (as illustrated below). The same variant of the 1 handshape occurred in subject 4's production of the sign DIFFERENT, but only on the dominant hand.

Image 10 – Subject 4's production of target handshape 1

Target WHERE

Subject 4 WHERE (trial 1)

Subsject 4 WHERE (trial 2)

Target *Wait a minute*

Subject 4 *Wait a minute*

In the initial analysis of the data, almost all instances of negative transfer occurred with unmarked handshapes. The only exception was the case of W, already mentioned in the previous subsection. This highly marked handshape (or something like it) exists in conventional American gesture, namely in the gesture for *three* (not to be confused with the ASL sign THREE). In the stimuli, our signing model demonstrated this gesture with the tip of her pinky finger pinned under the pad of her thumb. In contrast, for both sign stimuli using the W handshape, our signing model did not use her thumb to pin down her pinky finger, but either placed it beside the thumb (WATER) or pressed its pad against the pad of the thumb (SIX-YEARS-OLD). Subject

Image 11 – Sign model and subject 10 handshapes for three, WATER, SIX-YEARS-OLD


Target three


Subject 10 three


Target WATER


Subject 10 WATER


Target SIX-YRS-OLD


Subject 10 SIX-YRS-OLD

10 pinned his pinky finger under the thumb for both instances of the gesture *three* as well as for all four sign tokens calling for the W handshape. This pattern suggests that subject 10 may have perceptually assimilated the model's W handshapes to an existing handshape category in which the tip of the pinky is pinned under the thumb, resulting in negative transfer in his sign production. Comparison of subject 10's handshapes with those of the sign model are shown below.

Finally, negative transfer from gesture did not occur in all cases where it was predicted to occur. For instance, the target Y handshape in the sign stimulus WRONG differs from the handshape in the target gesture *call me* in the degree to which the thumb and pinky are splayed. The two handshapes are otherwise very similar, and one might have expected subjects to transfer their handshape from the gesture *call me* to signs requiring the Y handshape. However, this did not occur in the majority of cases. As mentioned earlier, all four subjects accurately reproduced the gesture *call me*, with the

Image 12 – Subject 10 handshape for call me and WRONG


Target *call me*


Target WRONG


Subject 10 *call me*


Subject 10 WRONG

pinky and thumb splayed widely. They also (even subject 10) accurately reproduced the Y handshape of the target sign WRONG, in which the pinky and thumb were not widely splayed.

In this case I agree with Rosen (2004) that marked handshapes do not necessarily pose the same production challenges for M2 learners as they do for L1 child learners whose motor skills are still developing. After all, even complete ASL novices, such as the subjects in this study, were able to accurately reproduce the ASL handshape in WRONG after seeing it for the first time. Nevertheless, comparison of these cases of non-transfer with the cases of transfer documented earlier for subject 4 suggests that markedness may actually exert a subtle influence in *both* cases. While subject 4 was able to perceptually extract unmarked handshapes 1 and S from sign stimuli and "recognize" them as being part of her existing gestural inventory, highly marked handshape Y apparently did not trigger this same kind of recognition for subjects, and thus was not subject to transfer. Alternatively, of course, subjects' success in producing distinct Y configurations for their gestures and signs could indicate that they accurately distinguish the two in their perception. The data sample for this pilot study is too limited to rule out either interpretation.

Results from recoding of Subject 4 data

Subsequent to the initial data analysis reported above, the data from subject 4 was recoded using the recent sign phonetic notation system recently presented by Johnson (2008). This exercise was intended as a small test of the claim, often made by Johnson and others, that researchers can see very different patterns in the data depending on what kind of notational system they adopt for coding. The effects of recoding on the interpretation of the data from subject 4 can be represented by the specific examples summarized below.

(1) Recoded data led to the same basic generalizations as the initial coding, but greatly increased the degree of certainty with which these generalizations could be made. The initial analysis of subject 4's production of the 1 handshape identified an error pattern by which the thumb of her dominant hand was consistently in an unopposed position, leading to the proposal of transfer as a factor affecting her production accuracy. Recoding did not change this result, but it did significantly facilitate the coding process. According to Johnson (2008), the feature I initially coded as thumb opposition depends on the joint effects of palmar abduction (the degree to which the thumb is extended forward away from the palm) and radial abduction (the degree to which the thumb is extended laterally away from the index finger). Coding each of these sub-features in turn was significantly more straightforward than coding for thumb opposition, with the result that the second analysis proceeded more quickly and with far less tortuous equivocation than the initial analysis.

(2) Recoded data revealed generalizations that were previously overlooked due to lack of detail. The initial coding focused on the degree to which the pinky and thumb were splayed (abduction), roughly determined by the angle between these digits and the nearest neighboring finger. Despite this relative straightforwardness of coding, it did not lead to a clear overall pattern of hand configuration accuracy. In particular, several of the configurations coded as having splayed pinky and thumb (like the target form) nevertheless still looked different from the target form.

Recoding of these hand configurations revealed that this difference lay in the degree of flexion of the closed fingers: in the target forms of WRONG, SAME and MEASURE, the first set of knuckles (MCP) are only partially flexed, while they are fully flexed in the gesture *call me*. As a result, the full length of the metacarpal bone (c) is visible to the camera in WRONG, and fingers 2, 3 and 4 appear loosely closed in SAME and MEASURE. In both subject 4's gesture and sign production, the MCP was fully flexed, altering the overall appearance of the hand configuration. Although this difference was immediately noticeable, the initial analysis could not capture it, since it did not consider finger flexion. The reanalysis revealed that while the model used distinct configurations for gestures and signs, subject 4 used the same configuration for both, representing another potential example of negative transfer that was missed in the original analysis.

(3) Recoded data led to a reinterpretation of the data that directly contradicted the interpretation under the initial coding method. Although there were no cases in which initial coding and recoding of the same feature resulted in clearly contradictory results, I did encounter a related situation in which the recoding process exposed a generalization presented in the initial analysis that was inconsistent with the stated coding criteria. According to the initial analysis, none of the subjects scored above 50% accuracy for the open-8 handshape, a pattern I attributed to the marked status of that handshape. Recoding did not change the overall accuracy scores for the subjects, but it revealed that subject error lay mainly in the degree of flexion of the non-selected digits (in this case, the thumb, index, ring finger and pinky). The initial coding, which did not include flexion, should have been limited to finger and thumb splay, features that alone do not account for the subjects' low accuracy scores. Apparently, my summary of the initial analysis was influenced by subjective impressions about finger and thumb position that were not formally included in the coding process. Although the ultimate interpretation on subject accuracy for open-8 remained unchanged across both analyses, my error is a reminder that clear coding criteria, based on an objective notation system with sufficient phonetic detail, play an important role in constraining researchers' perception of the data to only the features on which they claim to base their analysis.

Conclusions

Previous research on the production of ASL signs by new hearing adult learners of sign language (M2 learners) discounts markedness and transfer as potential factors affecting handshape accuracy (Rosen 2004). However, the limited pilot data presented here provide support for individual effects of markedness and transfer, both individually and interactionally, in M2 signing. These preliminary data also suggest that transfer (both positive and negative) is in some cases blocked for highly marked handshapes. In the terminology of speech perception models such that advanced by Best (1995), markedness appears to be a factor that can prevent learners from perceptually assimilating certain handshapes to similar handshapes that they use in gesture and for which they already have an established handshape category. I propose that in such cases, subjects approach the target sign as an unfamiliar bundle of handshape, movement and location features that they must do their best to replicate in a short period of time. Their adult cognitive skills are sufficient to ensure accurate reproduction in some cases (e.g. the Y handshape in WRONG for subject 10) but not in others (eg. the W handshape in WATER for subject 4), where they make errors reminiscent of those observed in the L1 ASL of young signers.

Of course, markedness and transfer alone cannot account for all the handshape errors that M2 signers produce. In some cases marked handshapes were reproduced with higher accuracy than expected, even when these handshapes were distinct from handshapes used in common American gestures, and therefore assumed to be novel for our subjects. In these cases, I agree with Rosen (2004) that the cognitive abilities of adult learners sometimes prevail over markedness, allowing for accurate reproduction of the target handshape where a child learner might typically fail. This serves as a reminder of the fundamental complexity of second language acquisition in general: each adult learner brings a unique combination of linguistic experience, aptitude and motivation to the task of a new language, such that no two learners will follow the same developmental path. When the new language also happens to be of a different modality than the learner's native language, additional challenges may arise. The most effective approach to M2 sign phonology must recognize a variety of factors that influence accuracy, as well as the complex ways in which these factors may interact.

Bibliografia

1. Armstrong, N. and M. Wagner (2003) *Field guide to gestures: how to identify and interpret virtually every gesture known to man*. Philadelphia: Quirk.
2. Axtell, R. (1997) *Gestures: The Do's and taboos of body language around the world*. Wiley.
3. Best, C. (1995) A direct realist vew of cross-language speech perception. In W. Strange (ed.), *Speech perception and linguistic experience: issues in cross-language research*. Baltimore, MD: York Press. 171-204.
4. Boyes-Braem, P. (1973/1990) Acquisition of handshape in American Sign Language. In V. Volterra & C. Erting (Eds.), *From gesture to sign language in hearing and deaf children*, Springer-Verlag, 107–127.
5. Chen Pichler, D. (to appear) Sources of handshape error in first-time signers of ASL. In D. J. Napoli and G. Mathur (eds). *Deaf around the world. Oxford: Oxford University Press*
6. Flege, J. (1995) Second language learning: Theiry, findings, and problems. In W. Strange (ed.) *Speech perception and linguistic experience: issues in cross-language research*. Baltimore, MD: York Press. 233-237.
7. Jakobson, R. 1968. *Child Language, Aphasia and Phonological Universals*. The Hague: Mouton.
8. Johnson, R. E. (2008). Conversations toward an international phonetic notation for signed languages. Handout from The Second Workshop on the Phonetic Notation of Signed Languages, Université de Paris-Sud, Orsay, France. June 2008.
9. Liddell, S. and B. Johnson (1989). American Sign Language: the phonological base. *Sign Language Studies*, 64, 195-277.
10. Major, R. (2001) *Foreign accent: The ontogeny and phylogeny of second language phonology*. Mahwah, NJ: Lawrence Erlbaum Associates.
11. Mayberry, R. I. and E. B. Eichen (1991). The long-lasting advantage of learning sign language in childhood: Another look at the critical period for language acquisition. *Journal of Memory and Language*, 30, 486-512.
12. McIntire, M. (1977) The acquisition of American Sign Language hand con – figurations. *Sign Language Studies* 16:247-266.
13. Mirus, G., C. Rathmann, and R. Meier. (2001) Proximalization and distalization of sign movement in adult learners. In V. Dively et al. (eds.) *Signed languages: Discoveries from international research*, 103-119. Washington, DC: Gallaudet University Press.
14. Mitchell, R., T. Young, B. Bachleda and M. Karchmer (2006) How many people use ASL in the United States? Why estimates need updating. *Sign Language Studies* 6(3): 306-38.
15. S. Prillwitz, R. Leven, H. Zienert, T. Hanke, J. Henning, et al. (1989) Hamburg Notation System for Sign Languages – An Introductory Guide. *International Studies on Sign Language and the Communication of the Deaf, Volume 5*., Institute of German Sign Language and Communication of the Deaf, University of Hamburg.
16. Rosen, R. (2004) Beginning L2 production errors in ASL lexical phonology. *Sign Language and Linguistics* 7:31-61.
17. Stokoe, W.C., D.C. Casterline and C.G. Croneberg (1965*). A dictionary of American Sign Language on linguistics principles*. Silver Spring, MD: Linstok Press.
18. Takkinen, R. (2002). *The secrets of handshapes: The acquisition of handshapes by native signers at the age of two to seven years*. Translated summary (154-172). Deaf Studies in Finland, Volume 1. Publisher: Kuurojen Liitrrory. [Original title: Kasimuotojen salat: Viittomakielisten lasten kasimuotojen omaksuminen 2-7 vuoden iassa.]
19. Wilbur, R. (2004). After 40 years of sign language research, what do we know? In S. Bradaric-Joncic, & Ivasovic, V (eds.), *Sign language, deaf culture & bilingual education*. Zagreb: University of Zagreb.

Appendix A: Stimuli list

Note: For two-handed signs in which both hands form the same handshape, each hand was counted separately to arrive at the calculations of accuracy presented in Image 5.

Highly unmarked handshapes	
S	**Gesture:** ***Yes!***
	Signs: WORK, SENATE, SYMBOL
1	**Gesture:** ***One/wait a minute***
	Signs: DIFFERENT, WHERE
Moderately unmarked handshapes	
B-dot	**Gesture:** ***Stop!***
	Signs: MINE, YOURS, SCHOOL, PLEASE
Moderately marked handshapes	
Y	**Gesture:** ***Call me***
	Signs: SAME, MEASURE, WRONG
W	**Gesture:** ***Three***
	Signs: WATER, 6-YEARS-OLD
Highly marked handshapes	
open-8	**Gesture: none**
	Signs: MEDECINE, FEEL

Appendix B: Handshape notational symbols from Johnson (2008)

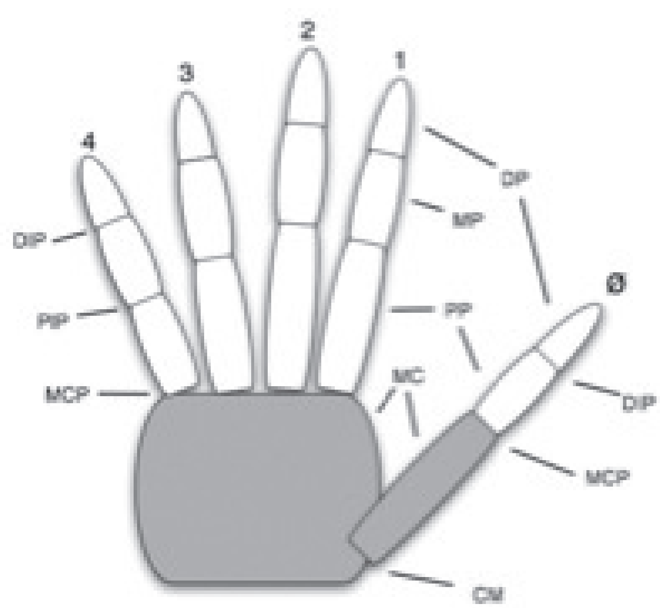
Domain	Sub-domain	*Feature tier*	Possible Values
Right (or Left) Hand Configuration	Thumb config	*ext HC*	+, -
		CM Opp.	O, U, L;
		CM Abd.	〈, <, =
		MCP Flex.	E,e,F,f
		DIP Flex.	E,e,F,f
	Th-Fing contact	Thumb Surf.; Bone	a,d,p,r,u; DI
		+/ – th/f contact	+,-
		F Surf.; Bone; Nos.	a,d,f,r,u; D,I,P,M; 1,2,3,4
	Finger config	1 MCP Flex.;	E,e,F,f
		1 PIP Flex.	E,e,F,f
		1 DIP Flex.	E,e,F,f
		Abd./Cross 1-2	〈, <, =, x, xp, xa, ⊗ r, rp, ra
		2 MCP Flex.	E,e,F,f
		2 PIP Flex.	E,e,F,f
		2 DIP Flex.	E,e,F,f
		Abd./Cross 2-3	〈, <, =, x, xp, xa, ⊗ r, rp, ra
		3 MCP Flex.	E,e,F,f
		3 PIP Flex.	E,e,F,f
		3 DIP Flex.	E,e,F,f
		Abd./Cross 3-4	〈, <, =, x, xp, xa, ⊗ r, rp, ra
		4 MCP Flex.	E,e,F,f
		4 PIP Flex.	E,e,F,f
		4 DIP Flex.	E,e,F,f

Categories of Flexion/ Extension
- F: fully flexed
- f: partially flexed
- e: partially extended
- E: fully extended
- h: partially hyper-extended
- H: fully hyper-extended

Categories of Abduction and Crossing
- 〈 widely abducted
- < neutral (slightly abducted)
- = adducted and adjacent
- x more-ulnar crossed over more-radial, normal position
- xp more-ulnar crossed over more-radial, more-ulnar on tip of more-radial
- xa more-ulnar crossed over more-radial, tip of more-ulnar on bone a of more-radial
- ⊗ hyper-crossed
- r more-radial crossed over more-ulnar, normal position
- rb more-radial crossed over more-ulnar, tip of more-radial of bone a of more-ulnar

CM Rotation:
- O Opposed
- U Unopposed (Neutral)
- L Laterally aligned

CM Abduction
- 〈 widely abducted
- < neutral (slightly abducted)
- = adducted and adjacent



Technical names of joints and bones (abbreviations)