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PHONOLOGY

ARTICLE

Modelling contrast and feature inventory: the nature of [web] in French Sign Language

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Abstract

Feature-based models of sign language use distinctive features to describe the phonological structure of signs. We use near-minimal pairs and phonological phenomena like productivity and neutralisation in French Sign Language to show that the feature [web], which refers to the webbing part of the fingers, should be (re)introduced into the list of phonologically active features. In discussing potential cases of [web] in other sign languages and the impact on the shape of phonological inventories, we first offer an account of [web] in terms of a location feature in line with most traditional feature-geometry models. We then offer some speculations on why a more uniform characterisation of [web] and the features in the same subclass in terms of the orientation type results in more economical models.

Contents

1. Introduction

Distinctive features are necessary when establishing the phonological concepts of *opposition, contrast, markedness* and *distinctiveness,* whether defined acoustically (Jakobson *et al.* 1952; Trubetzkoy 1969) or articulatorily (Chomsky & Halle 1968). These notions are highly relevant in feature systems across both spoken and sign language modalities. Spoken language models based on feature geometry (Clements 1985) have heavily influenced the hierarchical organisation of sign language phonology in

terms of structured groups and sub-groups of features (Sandler 1986, 1987a,b, 1989, 1993a,b,c, 1996; Ahn 1990; van der Hulst 1993, 1995, 1996; Brentari 1998; van der Kooij 2002; Sandler & Lillo-Martin 2006; van der Hulst & van der Kooij 2021).[1]

Lexical phonology is traditionally organised around five major phonological parameters in sign language, namely handshape, location, movement (Stokoe 1960), (hand-)orientation (Battison 1978) and lexical non-manual markers such as facial expressions (Brentari 1998). These parameters represent the fundamental categories with which sign language phonology determines lexical and sublexical contrasts (Sandler & Lillo-Martin 2006; Quer *et al.* 2017, among others).

In this study, we examine the phonological inventory of French Sign Language (*langue des signes française,* abbreviated LSF) and how distinctive features manifest in its composition. We discuss the part feature theory plays in defining contrast and its salient presence in the phonological analysis of signs. More specifically, feature contrast is used in LSF to argue for the phonological status of one particular hand-part known as the *webbing*, that is, the interdigital folds. We do so by investigating the various ways in which contrast emerges in sign language phonology, including saliency, minimal pairs, near-minimal pairs, changes of phonological contexts, and phonological processes such as productivity (i.e., the creation of new signs), and neutralisation. Evidence from LSF will lead us to (re-)introduce [web] in the set of features from which language-specific phonological inventories are created. In the rest of the article, we will use 'webbing' to refer to the anatomical part of the hand, and [web] for the relevant feature associated with it. A conservative approach to the empirical findings presented in this article will lead us to treat [web] as part of the location features that constitute the sub-specification of the non-dominant hand, in line with Liddell & Johnson (1989). On the dominant hand, webbing is active in determining orientation. Although the impact of adding a single feature to an already rich feature inventory may appear minimal, the addition of [web] unveils unexpected redundancies. In examining these effects, we will refine the phonological nature of [web], providing a compelling proposal that it is an orientation feature on both the dominant and the non-dominant hand.

The rest of the article is organised as follows. §2 presents a brief overview of how contrast in sign language phonology is understood in broad terms, going beyond minimal pairs. Key elements of sign language phonology that are necessary for the analysis of [web] are also introduced in this section. §3 illustrates how [web] has been analysed in American Sign Language (ASL). §4 contains the main empirical contribution of the study. The distribution of [web] across various types of signs in LSF is carefully described, as well as the empirical evidence that [web] generates phonological contrast. A cursory look into the lexicon of Italian Sign Language (*lingua dei segni italiana,* abbreviated LIS) shows a similar distribution of [web] as seen in LSF. §5 implements an analysis of [web] in traditional feature geometry models. In §6, we discuss the impact of our findings and depict how contrast shapes phonological inventories in sign language. We also offer a novel theoretical perspective on the natural class associated with the [web] feature. Finally, §7 concludes the article.

2. Contrasts and features in sign languages

At the segmental level, minimal pairs are generally regarded as one of the most valuable resources for determining phonological inventories, because they are usually considered a sufficient condition to identify phonemes in spoken language (Pike 1947; Trubetzkoy 1969; but cf. Harris 1951; Chomsky 1964). The situation is more complex with sign languages, mostly due to the fact that minimal pairs, as well as allophonic pairs, are more difficult to identify on the feature level (Eccarius & Brentari 2010). As a consequence, sign language phonologists struggle to properly distinguish features that are phonologically motivated from those that are simply articulatory. The difficulty in identifying minimal

[1] Feature-based models that do not use a geometric approach are Liddell & Johnson (1986, 1989), Liddell (1990, 1993), Johnson & Liddell (1984, 2010, 2011, 2012) and Liddell (1984). Note that Liddell and Johnson's more recent works aim at offering a phonetic implementation rather than a phonological one. Models based on the moraic structure of signs have been proposed by Perlmutter (1990, 1991, 1992), and mathematical geometry models by Uyechi (1995, 1994).

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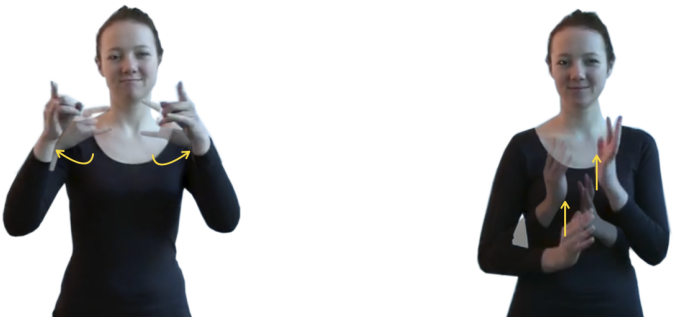

(a) WINDOW (b) FIRE

Figure 1. *Symmetric signs in LSF.*

pairs and their associated phonological processes in the visual modality results in the fact that inventory composition and size remain poorly understood.

This does not mean that there is no phonology in sign language; minimal pairs are not a necessary condition to determine phonologically active features. Other criteria that may be used include phonological processes targeting specific features, such as assimilations and diachronic or synchronic changes (see, e.g., Brentari 1998: 54). In addition, near-minimal pairs are worth investigating to identify the phonological inventory of a language, as well as the degree of saliency that individual features may bring in any given specific phonological context. These are the tools available to sign language phonologists when determining the inventories of specific sign languages.[2] These tools will be used in the following sections to argue for the phonological status of [web] in LSF (see Morgan 2022 for a different view, according to which only minimal pairs at the feature level should be considered when determining the phonological inventories of sign languages).

Before illustrating the details of how [web] has been analysed in the literature, two more aspects of sign language phonology must be introduced. The first is the use of the non-dominant hand as the location of a sign and the second is the notion of relative orientation.

For location, signs are articulated either in the *neutral space* or on some part of the body (the head, the torso, etc.).[3] While some signs are produced with only one hand, which is typically the signer's dominant hand, other signs require both hands.[4] In the latter case, the non-dominant hand produces either a symmetric or an alternating copy of the dominant hand (see the signs in Figure 1), or serves as a base upon which the dominant hand actively produces the sign (see the signs in Figure 2).[5] For these asymmetric signs, the non-dominant hand acts as a major location (Brentari 1998), which means that signs like AGAIN, MUSHROOM and NAME in LSF are produced on the non-dominant hand. Like the

[2]See Clements (2001) for a typology of contrast types (distinctive, active and prominent) and Eccarius & Brentari (2010) for a comprehensive study of these contrasts in classifier constructions in sign language.

[3]In this article, we use the term 'neutral space' in a broad, generic and pre-theoretical way to refer to the space in front of the signer.

[4]The still images of ASL and LSF signs in this article are produced by right-handed signers; examples from LIS are produced by a left-handed signer.

[5]Readers who are familiar with sign language phonology may have noticed that we are glossing over several details. Specifically, two-handed signs are traditionally divided into three categories depending on their fine-grained articulatory properties (Battison 1978). These details are irrelevant to the discussion presented in this article. For the sake of concreteness, we use the term *symmetric sign* to refer to signs where the two hands move in space in a similar way either symmetrically or alternately. All these signs are produced on some abstract plane in the neutral space (horizontal, vertical or lateral) or are anchored to a major body location. We use the term *asymmetric sign* to refer to signs in which the non-dominant hand acts as a major location, either with the same handshape as the dominant hand or with a different handshape. In this respect, our partition follows the distinction between balanced and unbalanced signs proposed in van der Hulst & Mills (1996).

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(a) AGAIN (b) MUSHROOM (c) NAME

Figure 2. *Signs in LSF located on various sub-parts of the non-dominant hand: (a) the palm, (b) the tip of the finger or (c) the radial side of the selected fingers.*

other major locations, the hand can be divided into more precise (sub-)locations. For instance, AGAIN is produced on the palm of the non-dominant hand (Figure 2a), MUSHROOM on the tip of the finger (Figure 2b) and NAME on the radial side of the selected fingers (Figure 2c).[6] Based on ASL data, the set of features listed in (1) has been proposed as characterising the hand-part specification for signs articulated on the non-dominant hand.[7]

(1) *Active features on the non-dominant hand*
Palm of the hand, back of palm, front of selected fingers, back of selected fingers, radial side of selected fingers, ulnar side of selected fingers, tip of selected fingers/thumb, heel of hand.

As for (hand-)orientation, after an initial proposal saying it was captured in absolute terms by anchoring the dominant hand to the position of the signer's body (Battison 1978; Sandler 1989; van der Hulst 1993; van der Hulst & Mills 1996), the field converged in defining orientation in relative terms 'by specifying how the hand relates to the place of articulation (Friedman 1976; Mandel 1981)' (Crasborn & van der Kooij 1997: 38). Following this definition, orientation becomes a derived parameter that combines a specification of the articulator with a specification of the place of articulation of the sign.[8] Operationally, this is achieved by postulating a set of orientation features on the dominant hand that are distinct from handshape features and that are used to specify a facing relation with the location parameter. This set of features is identical to that used to specify the sub-location of signs articulated on the non-dominant hand, listed in (1) (Brentari 1998). To illustrate, we provide the description of relative orientation for the LSF one-handed sign EXPENSIVE (Figure 3a), the symmetric two-handed sign WINDOW (Figure 3b) and the asymmetric two-handed sign AGAIN (Figure 3c). The back of the selected fingers of the dominant hand is facing the cheek in EXPENSIVE; the tips of the fingers of both hands are facing each other in WINDOW and the tips of the fingers of the dominant hand are facing the palm of the non-dominant hand in AGAIN.

[6]Selected fingers are the active fingers of a handshape, that is, those that can move during the production of the sign or be in contact with the body, or that are overall more prominent (Mandel 1981).

[7]This list is essentially the one proposed in Brentari (1998); other models may have slightly different labels for essentially the same hand sub-locations and having more options in this pool is not an issue as long as they are empirically motivated.

[8]Under this view, orientation is the only parameter derived by the combination of features that belong to other parameters, while handshape, location, movement and non-manual components are not. In one-handed signs and asymmetric two-handed signs, the articulator is the dominant hand, while in symmetric two-handed signs, both hands are the articulators, and the location is a plane in the neutral space. In the phonological representation of signs, orientation is specified on the articulator node, before the selection of one or two hands. For clarity, we refer to orientation features as being specified on the dominant hand to contrast with the non-dominant hand as a location, but the specification remains identical in the derived phonological structure.

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(a) EXPENSIVE (b) WINDOW (c) AGAIN

Figure 3. *LSF signs illustrating relative orientation: (a) back of the fingers facing the cheek; (b) tip of the fingers of both hands facing each other (c) tip of the fingers facing the palm.*

As a reviewer correctly pointed out, this way of capturing orientation leaves some redundancy in the system. In fact, multiple feature combinations can lead to the same surface orientation for some signs. To illustrate, in the LSF sign AGAIN (Figure 3c), orientation could be described by specifying a palm feature on both hands. This would suffice to capture relative orientation, although it would also require some exceptional specification to derive contact between the tip of the fingers on the dominant hand and the palm of the non-dominant hand. Phonological criteria, among which saliency is most likely the easiest to visualise, are normally used to identify the correct orientation feature, thus reducing this type of redundancy.[9]

Independently from the chosen orientation features, the contribution of these anatomical parts is not used to determine the handshape parameter in sign language phonology (Quer *et al.* 2017). In fact, the features that determine a handshape are typically those that select the number of fingers and specify their configuration (flexed, spread, etc.). The idea that the same set of features characterises properties of both the dominant and the non-dominant hands in asymmetric signs is not particularly surprising. What is surprising is that they belong to two separate parameters, namely orientation and location. This redundancy has already been noted in the literature (see, e.g., Brentari 1998), and will be further addressed in §6.3.

3. Different views on webbing

The webbing part of the hand has received little attention in sign language phonology; in this section, we identify two potentially related reasons. First, it is difficult to identify contrasts based on this hand part; second, very few signs make use of it. To the best of our knowledge, webbing and its feature implementation [web] have been discussed only in the literature on ASL.

Liddell & Johnson (1989) report some examples in which they claim the webbing is involved in the articulation of ASL signs, as shown in Figure 4.[10] The signs WRESTLING, PREGNANT and FOOTBALL are symmetric two-handed signs. They are produced in the neutral space with the two hands interlaced to the point that the webbing parts of the two hands touch each other either throughout the articulation of the sign, as in WRESTLING (Figure 4a), or at the end of the movement, as in PREGNANT and FOOTBALL (Figure 4b and c).

[9] A separate but still relevant point concerns the position of the two hands in the space in front of the signer for asymmetric signs. Relative orientation as presented here does not capture this aspect, and additional structure is needed. This is a known problem among sign phonologists, although never addressed in detail. We hope to revisit this point in future research.

[10] All ASL data presented in this article are adapted from Lifeprint (www.lifeprint.com) (Vicars 1997). The arrows have been added to the original pictures (video screenshots) to clarify the movement trajectory.

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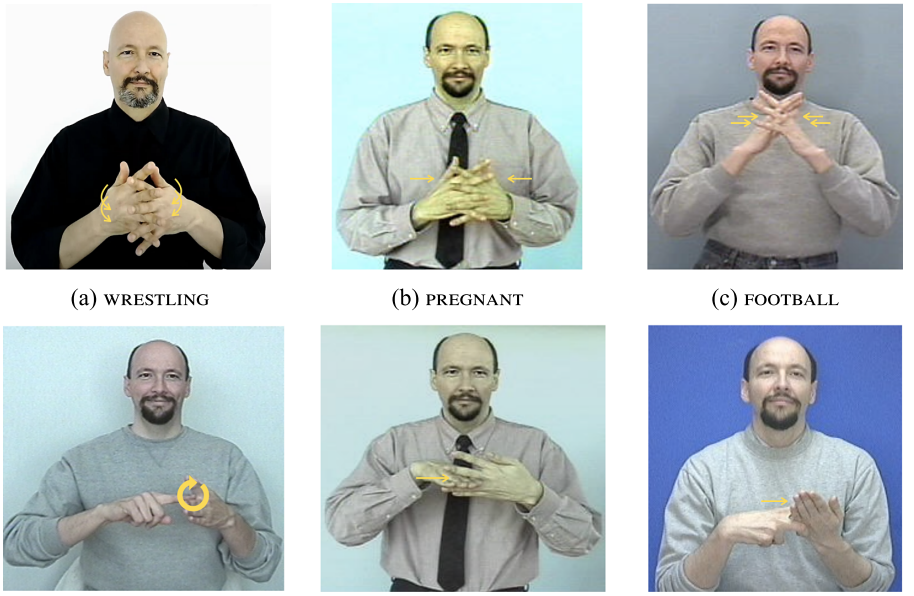

(a) WRESTLING (b) PREGNANT (c) FOOTBALL

(d) START (e) BREAK (f) TICKET

Figure 4. *Signs located on the webbing in ASL.*

The main difference among these signs is the movement component. In WRESTLING, the movement is a directional path repeated twice, while in PREGNANT and FOOTBALL, the hands move towards each other until contact, twice in FOOTBALL and only once in PREGNANT. Since these are symmetric two-handed signs, orientation is captured by facing the relevant hand part to the plane of articulation. Following the analysis proposed in Brentari (1998), the ulnar part of the hand is relevant; hence, the plane of articulation must be the horizontal one for WRESTLING and PREGNANT, and the vertical one for FOOTBALL.

The signs START and BREAK are two-handed asymmetric signs (Figure 4d and e). The webbing of the non-dominant hand is the point of contact with the dominant hand either throughout the movement, as in START, or at the end of the sign, as in BREAK. Orientation could be captured by [finger front] on the dominant hand and [ulnar] on the non-dominant hand. Finally, the webbing part of the dominant hand is used as the point of contact with the ulnar side of the non-dominant hand at the end of the movement in the sign TICKET (Figure 4f). One possibility to capture the orientation of this sign is to specify [ulnar] on the non-dominant hand and either [radial] or [ulnar] on the dominant one, following what is suggested in Brentari (1998). We will return to the orientation of TICKET and the other ASL signs later in the discussion.

While it is clear that the webbing is involved in the articulation of these ASL signs and possibly others, the discussion has focused on two main points: (1) the phonetic/phonological status of webbing (Liddell & Johnson 1986, 1989; Sandler 1986; Brentari 1998) and (2) its implementation within the macro phonological categories of signs, that is, location *vs.* movement (Stokoe 1960; Liddell & Johnson 1989; Brentari 1998).

The lack of clear cases of (near-)minimal pairs, phonological processes targeting this specific part of the hand and other types of contrasts are sufficient reasons to treat [web] as a purely phonetic feature in ASL, as suggested in Liddell & Johnson (1989) and explicitly implemented in Brentari (1998).

If it is treated as a pure phonetic feature, though, the issue is how to account for its use in signs like those in Figure 4. Stokoe (1960) treats it as a movement feature which he labelled *entrant*. In his model, this feature indicates that a part, generally the finger(s) of the dominant hand, intersects the space between two fingers of the non-dominant hand. In other words, the use of the webbing is predictable given the type of movement: it should emerge every time the fingers of one of the two hands

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interlace with some other part of the articulators.[11] Liddell & Johnson (1989) consider webbing to be relevant for the location parameter in ASL and propose a [web] feature to capture those signs in which contact with the webbing is found. However, they do not provide evidence for phonological contrast, and hence the feature is to be considered active at the phonetic level only. Furthermore, they do not provide a clear environment that would make its emergence predictable. Finally, Sandler (1986) and Brentari (1998) do not include it in the set of active features of ASL. More specifically, it is explicitly excluded in Brentari (1998), where [web] is treated as an allophonic variant of the [ulnar] feature.[12] Indeed, all the examples involving it are analysed as cases of [ulnar], because this part of the hand is also involved in the articulation of the signs. Since [ulnar] is a location feature when active on the non-dominant hand and an orientation feature when active on the dominant hand, its allophone [web] should belong to the same categories. The only active phonological feature in the ASL lexicon is [ulnar] in Brentari's system, with [web] specified only at the phonetic level to meet more precise descriptive adequacy.

To summarise, [web] is rarely found in ASL signs, and phonological contrast is hard to detect in those few cases. These facts have led researchers to grant it a purely phonetic status and not to consider it as one of the active features of the ASL inventory. Finally, although it was originally identified as a movement feature, more recent proposals treat it as a location feature.

While this is most likely correct for ASL, treating [web] as a purely phonetic feature in all sign languages, and therefore excluding it from the inventory of contrastive features, may not be fully justified. In this perspective, [web] could be viewed as a particularly marked feature and therefore rarely used across sign languages.[13] It would be similar to rare sounds in spoken languages that are allophonic in most languages but used contrastively in a few others, such as the voiced uvular trill [ʀ], which is used contrastively in languages like Japería (Oquendo 2004), as opposed to other languages, in which it is used in pre-vocalic position, as in Luxembourgish (Gilles & Trouvain 2013); for replacing /q/ before liquids, as in Selkup (Helimski 1998); or as a dialectal variant in languages such as French (Fougeron & Smith 1993) or Catalan (Wheeler 2005: 24).

4. The [web] feature beyond ASL

The core part of the LSF data is presented in this section, after a brief description of the methodology used for data collection. We provide evidence supporting the inclusion of the feature [web] in the inventory of active features in LSF. Finally, we provide a cursory look into how the webbing is used in LIS.

A note of caution before going into the details of LSF. In many sign languages, some signs make clear use of the webbing as an articulatory component, but its use has iconic motivations. One example is the sign FLIP-FLOP (Figure 5a). This sign is found in many sign languages, with very small articulatory variants. Here, the corresponding webbing part on the foot is mapped onto the hand. Of course, this could be a reflection of the fact that the foot as a whole is mapped onto the hand. Still, the webbing part

[11] Even if we are not sure we are interpreting Stokoe's intuition exactly as intended, we intentionally leave this characterisation as broad as possible, because it allows for the possibility that [web]/[entrant] is phonetically active on the dominant hand in signs like CHERRY where a  handshape forks the ear. In these cases, the interlacing is between the fingers of the dominant hand and a body part other than the non-dominant hand.

[12] Two footnotes refer to this specific point in Brentari (1998): one mentions the ulnar part of the fingers (p. 326), and the other mentions the radial part (p. 329). In the text, we chose to keep [ulnar]; however, the analysis would not change and the results obtained would be identical if [radial] were chosen instead.

[13] There are several ways in which [web] can be considered marked. Besides the fact that is not used very much as a location, as witnessed by the very few signs documented, one can claim that its reduced surface makes it a more difficult region to target, hence more marked in production. The same reason would extend to perception: a small region is harder to see. We will come back to this point in §6.1.

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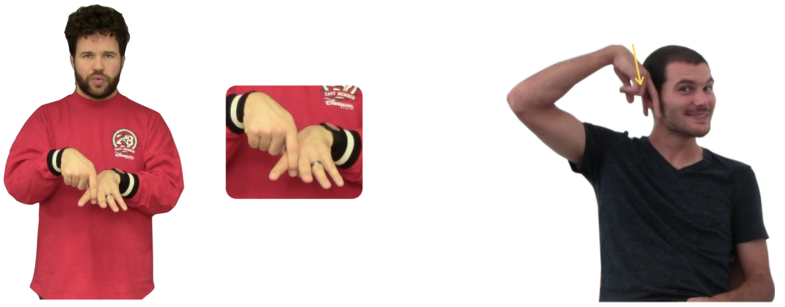

(a) FLIP-FLOP (b) CHERRY

Figure 5. *The signs (a) FLIP-FLOP and (b) CHERRY in LSF.*

of the non-dominant hand iconically contributes to the meaning of FLIP-FLOP, and hence it cannot act as a purely phonological feature.

For similar reasons, [web] is probably iconically motivated in CHERRY (Figure 5b): the  handshape represents the petioles of a pair of cherries, and the webbing is the point of contact where the cherries fork the ear.

We avoid these iconic uses of the webbing as much as possible to motivate our claim that [web] is a phonologically active feature in LSF, as their contribution is at best phonologically marginal, being forced by faithfulness to some iconic representation of the concept. Notice, however, that iconicity is not a categorical property of signs, but rather has a more gradient nature. In this respect, some signs that we discuss may have a more or less clearly iconic nature; what is crucial to us is that the webbing part does not play an iconic/morphological role. We will come back to the role of iconicity in §6 when we discuss its impact on phonological inventories.

4.1. Methodology

The LSF data presented in this section come from three main sources. The first source is the intuitions of two Deaf native signers of LSF who participated as language consultants in this study. Our main consultant, Thomas Lévêque, is from Bordeaux, and our second consultant, Yohan Marcelino, is from Lyon. The second source is drawings from dictionaries like the IVT dictionary (Girod & Vourc'h 1992) and Delaporte's (2007) etymological and historical dictionary of LSF. The third source is online sign repositories like *SpreadTheSign* (Hilzensauer & Krammer 2015), and *Le Dico Elix* (Houriez 2018). The LIS data come from discussions we had with Dr. Mirko Santoro, a Deaf linguist and native signer of LIS, and have been checked with Radutzky's (2001) drawing dictionary and *SpreadTheSign.* The examples presented in this article are signed by Dr. Santoro himself.

Since the relevant signs are citation forms produced in isolation, the methodology of elicitation was quite simple. After having explained the main goals of the research, we asked our consultants to name as many signs they could think of that involved the webbing either on the dominant hand or the non-dominant hand. As an example, we provided them with some LSF signs for which we already suspected that webbing was involved, such as MEAT and SHIT (see Figure 6a and c). Some of the signs proposed were clearly iconic, others much less so. We video-recorded all the signs they were able to produce in isolation and then focused on those for which the webbing was not clearly iconically motivated. In parallel, we consulted bibliographic and online resources to check whether these forms were generally attested or were part of the geographical variety or idiolect of our consultants. During the discussion of the target signs, we also looked at potential cases of (near-)minimal pairs, again by asking our consultants if articulatorily similar forms were part of the LSF lexicon and whether they could provide minimally different signs. In order to test whether allophonic forms were possible, as

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(a) MEAT (b) PSYCHOLOGY (c) SHIT

Figure 6. *The signs (a)* MEAT*, (b)* PSYCHOLOGY *and (c)* SHIT *in LSF.*

(a) CHEESE (b) FRIES (c) PICTURE

Figure 7. *The signs (a)* CHEESE*, (b)* FRIES *and (c)* PICTURE *in LSF.*

a final step conducted with one consultant only, each sign was presented on a video screen, and the consultant was asked whether the location/point of contact could be displaced to nearby locations, such as the ulnar or the radial side of the selected fingers.

Similarly to ASL, we have been able to identify only a handful of signs for which the webbing is clearly used. However, these forms reveal a much stronger contrastive pattern in LSF than the one observed in ASL, as shown below.

4.2. [web] in LSF

The webbing is used in asymmetric two-handed signs like MEAT, PSYCHOLOGY and SHIT, illustrated in Figure 6. In these examples, the feature [web] refers to a point of contact on the non-dominant hand, hence establishing the specific location of the sign. The variants of ACCOMPLICE, POTATO and TOOL used in Lyon also belong to this category.

In symmetric signs, [web] is found in CHEESE, FRIES and PICTURE, as illustrated in Figure 7. Following the traditional approach to sign description, the correct location for these signs is the neutral space and the non-dominant hand is a copy of the dominant hand. In these cases, [web] is used as an orientation feature rather than a location feature.[14]

[14] An anonymous reviewer pointed out that the signs FRIES and PICTURE look quite different even though handshape, orientation and location are described by the same set of features. As mentioned in fn. 9, this is because relative orientation does not capture the global positioning of the hands in this type of sign.

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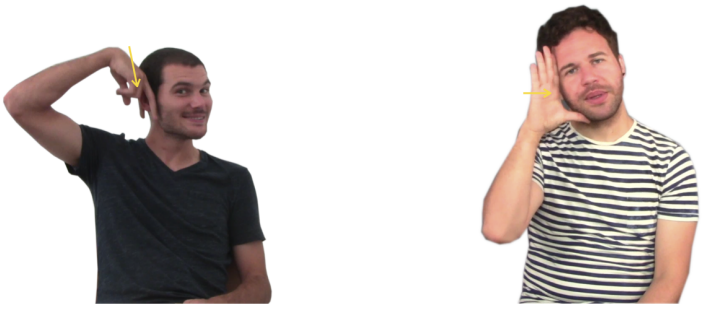

(a) CHERRY (b) BEDROOM

Figure 8. *The signs (a)* CHERRY *and (b)* BEDROOM *in LSF.*

Figure 9. *The sign* BEGIN *in LSF.*

The signs CHERRY and BEDROOM are illustrative of cases where [web] is involved in one-handed signs (see Figure 8). As in the examples documented in Figure 7, [web] is relevant in determining orientation. Slightly more complicated is the case of BEDROOM, which is also an iconic sign (the iconicity being in the head resting on a pillow). Here, the use of [web] may not appear as salient at first glance. In fact, one could argue that orientation is determined by considering the tip of the selected fingers (or the radial side), because they instantiate contact with the face. However, this approach falls short, since the tip of the index finger and the tip of the thumb make contact with two distinct and contrastive locations, namely the forehead and the lower part of the chin. Hence, [web] facing the cheek is probably the least problematic feature to capture orientation in a simple way.[15]

Finally, [web] is also involved on the dominant hand of two-handed asymmetric signs like BEGIN (Figure 9), in which [web] is the point of contact with the non-dominant hand. In this case, [web] is used as a reference point to determine orientation.

The distribution of [web] across the various types of signs demonstrates that, although marked, the feature is actively used in LSF. We also observed, in passing, that its use in determining the appropriate location and orientation results in simpler phonological descriptions. However, more is needed to argue that [web] should be treated as a phonological feature and not a simple phonetic feature in LSF. In the rest of this section, we present four arguments to support our claim: the presence of near-minimal

[15] An alternative way to capture orientation that dispenses with the use of [web] would involve secondary location features. For instance, if both [forehead] and [lower cheek] (or [chin]) are claimed to be active, one as a primary and the other as a secondary location feature, then the dominant hand may use two contact points (and hence two distinct selected fingers, the index and the thumb, respectively). Even if it is not implemented in existing models, this is feasible, although the resulting phonological representation of the sign would be unnecessarily complicated.

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(a) SHIT (b) EGG-1

Figure 10. *The near-minimal pair (a)* SHIT *and (b)* EGG *in LSF.*

(a) FRIES (b) HOSTEL

Figure 11. *The near-minimal pair (a)* FRIES *and (b)* HOSTEL *in LSF.*

(a) PSYCHOLOGY (b) PICTURE

Figure 12. *The near-minimal pair (a)* PSYCHOLOGY *and (b)* PICTURE *in LSF.*

pairs, faithfulness with respect to the target feature, the presence of morphological processes targeting [web] and the presence of phonological processes targeting [web].

Examples of near-minimal pairs involving [web] in LSF are SHIT and EGG-I (Figure 10), FRIES and HOSTEL (Figure 11) and, more marginally, PSYCHOLOGY and PICTURE (Figure 12).

For SHIT and EGG-I, two-handed asymmetric signs with two  handshapes, the location is determined by contact with the non-dominant hand at the end of the movement and corresponds to the webbing for SHIT and the ulnar side of the middle finger for EGG-I. The two signs also slightly differ in their movement component: a straight movement in SHIT and an arc movement in EGG-I. Finally, orientation is determined by the ulnar side of the dominant hand facing the location feature in both signs. [web] is essential to correctly capture the location contrast and, *a fortiori,* the orientation.

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For FRIES and HOSTEL, two-handed symmetric signs with a  handshape produced in the neutral space, the movement of the two signs is slightly different. In FRIES, the two hands move towards each other in a repeated directional path, while in HOSTEL the movement is an aperture change; that is, the handshape changes based on the flexion of the base joints. What is crucially different is the point of contact, which is on the webbing for FRIES and the ulnar side of the selected fingers for HOSTEL.[16] In this case, the location of these symmetric signs is the neutral space, which means that [web] is acting as a pure orientation feature.

The last pair is represented by the signs PSYCHOLOGY and PICTURE (Figure 12). Both signs use the  handshape and are produced on the webbing part of the non-dominant hand, but they differ by more than two features: one is an asymmetric sign and the other symmetric, and the two have separate movement features as well. However, the pair shows that [web] is active in producing minimally different specifications on the dominant hand to determine proper orientation. Indeed, the ulnar side of the dominant hand faces the webbing of the non-dominant hand in PSYCHOLOGY, while the webbing is used in PICTURE.

These pairs show that the [web] feature is systematically active in building phonological contrast. This is true in asymmetric signs like SHIT and EGG-I where [web] acts as a location feature, as well as in symmetric signs like FRIES and HOSTEL where [web] acts as an orientation feature. If we were to analyse these LSF examples in the same way as the ASL signs, either as an allophonic alternation as suggested by Brentari (1998) or by treating [web] as purely phonetic as in Liddell & Johnson (1989), we would miss the salient difference between each pair in LSF, either at the location level or the orientation level. A similar problem emerges with Stokoe's model, since it would not be able to distinguish different degrees of entrance in signs like FRIES and HOSTEL. This is our first argument supporting the phonological status of [web] in LSF.

Our next argument is based on the degree of faithfulness to [web] and the possibility of entering into alternations with other neighbouring features in the phonological space, like [radial] or [ulnar]. To illustrate the point, we use the signs MEAT and PSYCHOLOGY (repeated in Figure 13a and d, respectively). In both cases, the point of contact clearly determines the activation of [web], at least at the phonetic level. Crucially, if some sort of free allophonic alternation were possible, small modifications of the point of contact are expected to produce acceptable forms, contrary to facts. The forms shown in Figure 13 where the location on the non-dominant hand is slightly shifted towards the radial side of the selected fingers for MEAT (Figure 13c) and towards the ulnar side of the thumb for PSYCHOLOGY (Figure 13e) are ill-formed. However, note that the webbing between the thumb and the index is much larger than the space between the other fingers. This allows for some leeway in the realisation of MEAT, and the fingers of the dominant hand may pinch non-central parts of the webbing, resulting in allophonic variants (Figure 13b). We take this as (mild) evidence that such minimal modifications are likely to trespass the phonological boundary towards distinct and contrastive features, like [ulnar] and [radial].

Note that ASL has a very similar sign for MEAT (see, e.g., the entry reported in the online dictionary Signing Savvy (https://www.signingsavvy.com/search/meat); Cartwright 2023). However, two different variants are reported in ASL-LEX, a lexical database of ASL (Sehyr *et al.* 2021), MEAT and MEAT_2.[17] These two variants might be phonologically related to the one reported in Signing Savvy. If this is the case, besides the different handshape, one can appreciate the fact that the sub-location of

[16] An anonymous reviewer correctly pointed out that HOSTEL seems to be an iconic sign because the final position of the hands may represent the shape of a roof, thus recalling a building. However, this has little impact on the point we are making, for two reasons. First, the fact that the interlaced fingers do not perform contact with the webbing but stop midway has nothing iconic in it; therefore, the presence of the [ulnar] feature is not iconically motivated. Second, our interest is in the sign where [web] is actually involved, namely FRIES. Here, the degree of iconicity is much less strong. Another reviewer wondered whether the way the fingers are interlaced in this type of sign (i.e., whether the ulnar side of the dominant hand faces the radial side of the non-dominant hand or *vice versa*) has any phonological meaning. For our LSF and LIS consultants, this difference is not predictable and completely allophonic. We believe that the same holds for ASL.

[17] We thank an anonymous reviewer for pointing us to this alternation.

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(a) MEAT (b) MEAT_2 (c) *MEAT

(d) PSYCHOLOGY (e) *PSYCHOLOGY

Figure 13. *Correct and incorrect forms for* MEAT *(a–c) and* PSYCHOLOGY *(d and e) in LSF.*

the sign has shifted from the webbing to the radial side of the non-dominant hand. Importantly, the degree of variation documented for [web] is much higher in ASL than the one attested for LSF. This constitutes a second argument to support the phonological status of [web] in LSF, in that its relevance for accurate articulation makes it particularly salient to prevent allophonic alternations.

Besides being active in the static lexicon, the webbing is also active as a target location in morphological processes like compounding. An example is provided with the sign PERVERT (Figure 14). In PERVERT, the dominant hand represents the victim, and the non-dominant hand the attacker. Since the two members of the compound instantiated by the two hands are articulated at the same time, this sign qualifies as a non-transparent simultaneous compound in LSF (Santoro 2018). It is non-transparent because the compound is not the combination of the sign ATTACKER and the sign VICTIM, but a classifier for small individuals (i.e., the pinkie finger representing the weakness of the victim) and an open handshape representing the attacker. The two hands asymmetrically move up and down, simulating the sexual aggression. The point of contact between the two hands is on the webbing of the non-dominant hand, as in the other asymmetric signs illustrated above. Compounding is a morphological process that also targets phonological features, and the emergence of such compounds where [web] is targeted is an indicator of productivity in the language. This is our third argument supporting the phonological status of [web].

Finally, we argue that [web] can enter in allophonic alternations with [ulnar] in the sign for EGG. The point of contact in EGG-1 can shift from the ulnar side of the middle finger in the citation form (Figure 15a) to the webbing in the allophonic variant EGG-2 (Figure 15b). Note that the variant EGG-2 is a genuine minimal pair with SHIT (repeated in Figure 15c), as the only difference is now in the movement component, an arc movement for EGG-2 and a straight movement for SHIT.

Looking further into the source of this alternation, there is good evidence that the allophonic variant EGG-2 is an historical relic of the older sign for EGG in LSF, as this form is reported as the original sign

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Figure 14. *The sign* PERVERT *in LSF (a compound).*

(a) EGG-1 (b) EGG-2 (c) SHIT

Figure 15. *The two variants of* EGG*, (a)* EGG-1 *and (b)* EGG-2*, and (c) the minimally different sign* SHIT.

(a) EGG (b) *Old sign for* SHIT

Figure 16. *Reproductions of the LSF signs (a)* EGG *and (b)* SHIT *presented in Delaporte (2007).*

for EGG in the *Dictionnaire étymologique et historique de la langue des signes franÃ§aise* (Delaporte 2007; see Figure 16a). The archaic sign for SHIT was also articulated differently in Old LSF. As shown in Figure 16b, the dominant hand has a handshape rather than a handshape, and the radial side enters into contact with the webbing instead of the ulnar side. The position of the non-dominant hand is also slightly different: the ulnar side of the hand faces the horizontal plane in the old form, while it is more vertical in the contemporary form.

It is possible to propose a historical explanation for the two variants of EGG.[18] Assuming that the old sign SHIT was the first to evolve into its current form, there was a period when EGG-2 and SHIT formed an actual minimal pair. In order to maximise the difference between these two forms, possibly because

[18] We thank an anonymous reviewer for pointing us in this direction.

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(a) JANUARY (b) TEAM (c) MOON

Figure 17. *Signs located on the webbing in LIS: (a)* JANUARY*, an asymmetric two-handed sign; (b)* TEAM*, a symmetric two-handed sign; and (c)* MOON*, a one-handed sign.*

the contrast in movement was not very salient, EGG-2 shifted its location from [web] to [ulnar], thus becoming EGG-1. The result of this process is the emergence of a phonological contrast between [web] on SHIT and [ulnar] on EGG-1. Unfortunately, we do not have data to corroborate this historical path. However, if correct, it is independent evidence that [web] was already phonologically active in Old LSF.

At the synchronic level, where the various pieces of the historical process are no longer available in the signers' phonological knowledge, new generations of LSF signers are exposed to the three forms in Figure 15. Under this perspective, the resulting alternation is no longer one of acquiring phonological contrast, but rather a neutralisation of contrast. More importantly, to properly describe the process, the feature [web] has to be active in the LSF phonological inventory because the output of the neutralisation is not [ulnar] but [web], the more marked feature. Specifically, in order to derive the form EGG-2 from EGG-1, the near-minimal contrast with SHIT is lost in favour of the [web] feature. The direction of the alternation from [ulnar] to [web] found in LSF is then the opposite of the one claimed for ASL, where potential cases of [web] are reanalysed as [ulnar].

To summarise, we have provided evidence that [web] is an active phonological feature of LSF in all types of signs. We showed its constrastive behaviour in near-minimal pairs, its categorical behaviour with respect to neighbour features, its use in the morphological process of compound formation and its place in the phonological process of neutralisation.

4.3. A quick look into [web] in LIS

A cursory investigation into the lexicon of LIS reveals that webbing is used as a location on the non-dominant hand in asymmetric two-handed signs and as an orientation feature in both symmetric two-handed signs and one-handed signs. An example of each type is provided in Figure 17 with the signs JANUARY, TEAM and MOON. In JANUARY (Figure 17a), the ulnar side of the index finger of the dominant hand touches the entire webbing between the index finger and the thumb of the non-dominant hand. The LIS sign TEAM (Figure 17b) is very similar to the LSF sign PICTURE. Here too, contact is made between the webbing of the two hands. Finally, MOON in LIS (Figure 17c) is similar to BEDROOM in LSF. To capture orientation in a simple way, the feature [web] facing the nose must be specified on the dominant hand. The alternative options of using the tip of the fingers or radial would require the use of secondary location features, as in the LSF sign BEDROOM.

More generally, the salience of [web] in one-handed signs like BEDROOM in LSF and MOON in LIS reveals a systematic way this feature can be used in the lexicon of sign languages. Specifically, when the location of the sign targets a phonologically dense space (e.g., the head, where contrast can be easily

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produced on the eye, nose, chin, etc.), handshapes with spread fingers may face multiple locations, systematically reproducing the problem of identifying orientation in a simple way.

These data points are in line with those from LSF. Even without an exhaustive list of examples to determine the phonological/phonetic status of [web] in LIS, there are enough to show its consistent presence in signs where it is not iconically motivated.

5. The analysis of [web]

The current account available for ASL treats [web] and [ulnar] as two allophones of the same phoneme /ulnar/. This led Brentari (1998) to propose a parsimonious model for ASL, and possibly for other sign languages, in which [web] is not among the features that determine the phonological inventory of a language. The data provided here show that this analysis does not extend to LSF. The key point is that [web] displays a variety of contrasts identifiable from near-minimal pairs, productivity and neutralisation, at least in LSF. These are the reasons motivating its inclusion in the pool of active features in this language. Specifically, it plays a role in determining the appropriate location on the non-dominant hand and relative orientation of the dominant hand. Furthermore, the current account may fall short in providing the correct orientation of some signs like TICKET in ASL and MOON in LIS.

In this section, we offer an analysis of the LSF data using a feature geometry. The analysis is not restricted to a specific model and can be easily implemented in any of the currently available models of sign language phonology with the following two minimal assumptions:

- The non-dominant hand provides the primary location in asymmetric two-handed signs.
- Orientation must be considered in relative terms as a relational property between a specified feature on the dominant hand and a specified feature on the location (see also §2).

Both assumptions are minimal as they have already been part of most sign language models and are empirically well supported (Battison 1978; Liddell & Johnson 1989; Sandler 1989; Uyechi 1995; Crasborn & van der Kooij 1997; Brentari 1998).

Once these are in place, the account for the LSF data is straightforward. The minimal move is to include [web] to the existing feature inventory. In other words, [web] is simply added to the list of features in (1), which represents both the active features of the non-dominant hand, that is, location features, and the active features that determine the orientation of the dominant hand.

For asymmetric two-handed signs like MEAT, PSYCHOLOGY and SHIT, it is enough to specify [web] as the location feature on the non-dominant hand. For symmetric two-handed signs like PICTURE, CHEESE and FRIES, [web] must be specified as the orientation feature on the dominant hand. A similar analysis extends to one-handed signs like BEDROOM.

An anonymous reviewer pointed out that in asymmetric signs like BEGIN (Figure 9) where the fingers are spread, [web] can be predictable if a location at the radial or ulnar side of the hand is chosen. This is essentially Brentari's (1998) proposal. While this may partially work for TICKET in ASL, it definitely does not work for LSF. In fact, phonologically similar signs like HOTEL and DANGER (Figure 18), as well as the sign NOT-BAD, all involving a  handshape on the dominant hand and located on the radial side of the non-dominant hand, fail to make contact with the webbing.

Once present in the pool of active features, [web] can then be targeted in morpho-phonological processes such as the creation of compound signs like PERVERT in LSF.

The fact that [web] does not normally alternate with phonetically similar features like [ulnar] or [radial] in signs like MEAT and PSYCHOLOGY may be due to its marked status and to the fact that webbing is the contact/endpoint of the sign movement, making it perceptually salient. These factors make [web] resistant to change, assimilation or location shift.[19]

[19] In a constraint-based framework, this resiliency can be captured by positing a feature-specific faithfulness constraint to be ranked above markedness constraints that would favour an alternation with [ulnar] or [radial]. This account also extends to the sign SHIT, which does not show any alternation, unlike the one observed for the near-minimally different EGG-1/EGG-2.

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(a) HOTEL (b) DANGER

Figure 18. *Asymmetric signs with spread fingers located on the radial side of the selected fingers instead of the webbing in LSF.*

As for the alternations between EGG-1 and EGG-2, it is unclear to us whether there is any phonetic or phonological environment conditioning the alternation. Our main informant uses both forms relatively freely. Here, we can tentatively postulate a neutralisation rule that takes the sign EGG-1 as input and returns the sign EGG-2 as its output. The process would then be sensitive to the relevant feature only. Specifically, the input feature would be [ulnar], the location feature of the non-dominant hand, which is changed into [web]. What is interesting in the alternation is that the process targets the relatively less marked [ulnar] feature and returns the more marked one, namely [web].

Extending this analysis to other languages is relatively straightforward. If phonologically active, [web] can be used to account for location and orientation. For instance, the sign JANUARY in LIS would specify [web] as a location feature on the non-dominant hand and [ulnar] as an orientation feature on the dominant hand. Orientation in the sign MOON in LIS can be captured by specifying [web] on the dominant hand and [nose] as location.[20]

6. Discussion

Data from LSF have shown that [web] is active in a variety of contrasts, hence proving that it should be included in the phonological inventory of sign language features. The data also provide compelling insights about the notion of phonological contrast and how this can be effectively used to generate mental representations of signs, that is, word-level phonology. In this section, we discuss the implications of using multiple criteria for phonological contrast to determine phonological inventories in sign languages and their theoretical ramifications.

6.1. Saliency

In the absence of quantitative metrics to determine a scale of articulatory and/or perceptual saliency of individual features in sign language, we can take the fact that it is difficult to identify signs that use the webbing part as the first evidence of the particularly marked character of [web]. In fn. 13, we also noted that the portion of the hand that can be the target for this feature is small when compared to other hand features like palm, finger fronts, radial and ulnar. This reduced space, we speculate, could be one

[20]If it turns out that the contact between the fingers and the two sub-locations is not a phonetic side effect in one-handed signs like BEDROOM in LSF and MOON in LIS, then the contact still needs to be explained from a phonological perspective. We leave this issue for future work.

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factor that makes [web] articulatory and perceptually less salient, and thus a disfavoured feature to mark contrast.[21]

Saliency is also one of the first indicators of phonological contrast (Brentari 1998; Clements 2009). If we allow saliency to be a sufficient criterion to determine the status of phonological features, we may have one argument to explain why [web] can be an allophonic (i.e., non-contrastive) feature in ASL but a phonological (i.e., contrastive) one in LSF. Just as spoken languages may employ different thresholds to discriminate the properties and the behaviour of specific sounds, the same may happen in sign languages. For example, the degree of sonority determines whether a sound can act as the nucleus of a syllable in spoken languages. Only vocalic sounds are allowed to fill that position in many Romance languages (Gabriel *et al.* 2022), while sonorant consonants can be nuclei in Slavic languages (Comrie & Corbett 1993). Analogously, sign languages may be sensitive to saliency in order to determine whether [web] can be manipulated by the phonological level of the grammar. In this respect, the grammar of ASL would be more restrictive, only allowing [web] to act as an allophone, while the grammar of LSF would be less restrictive, including [web] among the features that generate phonological contrast.

Webbing is rarely used in both languages, although its distribution is remarkably different. For ASL, aside from the sign TICKET, cases where webbing is involved are only reported in symmetric two-handed signs in which all fingers are selected. In signs like START and BREAK, contact with the webbing may not be so obvious, and perhaps the ulnar hand part is more salient than the webbing – or at least equally salient – in ASL. The analyses offered in the literature then can dispense with the use of [web] as an active phonological feature. On the other hand, [web] is used in LSF in a variety of configurations with multiple handshapes. From the perspective of saliency, however, the most important evidence that [web] is targeted rather than other locations is given by signs like BEGIN, MEAT, PERVERT, PSYCHOLOGY and SHIT. In these signs, [web] is the contact/endpoint of the sign movement, and small changes to neighbouring features generate ill-formed signs.

6.2. Consequences for phonological inventories

Feature-based models generate phonological inventories based on active features. Across sign languages, there is a pool of features that are systematically active. Typically, these are unmarked features, like those determining the extended index finger  , the fully closed  , or the open handshape  . Other, more marked features may or not be active depending on the specific language. Understanding which ones are phonologically active is certainly one of the most complicated challenges that sign language phonologists encounter when determining the inventory of active features for a specific language. Minimal pairs are probably the most powerful resource that researchers have to identify contrastive features. Unfortunately, as explained in the preceding sections, this tool is not of great help in the case of sign language (but see Morgan 2022 for a different view). Other types of contrasts must be used to determine the status of individual features. One of these is to relax the notion of minimal pair and consider near-minimal pairs as a sufficient criterion to determine contrast. Another is to use saliency, although this would require special stipulations, especially in the absence of phonetically measurable criteria. Finally, one can resort to (morpho-)phonological processes targeting specific features, like word-creation, deletion, replacement and metathesis.

An immediate consequence of this move is that there is a concrete risk of overestimating the number of active features for a specific language. Parsimony and economy are often used as leading criteria in modelling inventories (Clements 2003). This is what led Brentari (1998) to remove [web] from the pool of active features in ASL because the various combinations attested in the lexicon of ASL can be accounted for without making use of it. By extension, one should try to adopt similar explanations before introducing a new feature. This is what we first tried to do with LSF. It is only when faced with

[21] The tip of the finger is also a small portion of the hand, making it articulatory less salient. However, we assume that its location at the distal boundary of the hand makes it perceptually very salient, hence overall less marked.

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the impossibility of meeting descriptive adequacy that we have been justified in introducing [web] as an active feature. The burden of the proof was thus on our shoulders. However, the introduction of a new feature is not without consequences. On the one hand, it solves the problems that we highlighted; on the other hand, it introduces a certain amount of redundancy into phonological descriptions. Consider, for instance, the LSF sign FRIES (Figure 11a). In a system where [radial], [ulnar] and [web] are all active in the same phonological system, descriptive adequacy for orientation can be reached in at least three ways: by specifying any of [radial], [ulnar] or [web] for the dominant hand (the non-dominant hand would copy the same value, since it is a symmetric sign). The first two options would mimic the ASL analysis (and would require an additional neutralisation of [web]), while the third would simply target the relevant feature. This type of redundancy is widespread in sign language phonology and has been discussed with respect to handshape in Brentari (1998: 104). In a sense, this issue is not different from the one found, for example, when both [+sonorant] and [+syllabic] target sounds that can fit the nucleus of a syllable in a particular language. The challenge then is to understand whether there is a phonological need for all these features to be active within a language or not. This in turn creates the need to look for specific contrasts that might disentangle the issue. In our case, the LSF signs FRIES and HOSTEL illustrate the need for both [radial] or [ulnar] (for HOSTEL) and [web] (for FRIES).[22] Contrasts of this type allow us to reach an adequate explanation.

Phonological models for sign language should be taken as an overall indication of how features are organised within a system. Determining which ones are active at the phonetic or the phonological level in a specific language is then an empirical task. Not distinguishing the two levels and adopting a restricted set of features may result in more parsimonious and elegant models, but it risks having inadequate explanations for the phonological facts. Here, we documented the case of [web], which appears to be quite a marked feature, but which is still used contrastively in LSF. A similar observation can be made for highly marked handshapes (at least for many Western European sign languages) like those involving the ring finger as the only selected finger. While signs with this handshape are virtually absent in British, French, Italian and Spanish Sign Languages and extremely rare in ASL (e.g., the number 'eight'), they are not uncommon in Asian sign languages. Phonological models built on Western World sign languages may completely obliterate the existence of features that would allow a handshape to select the ring finger only. In doing this, they are more economical, but excluding these combinations of features from those that can in principle become phonetically or phonologically active would be a major mistake.

We want to conclude this section with a caveat concerning the interaction of iconicity and phonology in the composition of active features. Loosening the criteria to identify contrast is a necessity given the particular phonology of sign language. However, this move brings the risk of including more features than actually needed. This is especially true for signs that are clearly iconically motivated. Since iconicity is pervasive in the lexicon of sign languages, this claim needs to be qualified. We are not referring here to the global effect that makes form-meaning mapping easy to guess. Our caveat concerns the specific features that are iconically motivated in a sign. We partially discussed this point from a different angle when referring to the iconic status of HOSTEL in LSF (see fn. 16), but will clarify it further here. Suppose that signs like FLIP-FLOP, SKEWER and CHERRY are the main source of [web] in a sign language. The webbing part is a key factor in determining the iconic status of these signs. It has a direct one-to-one mapping with the webbing between toes in FLIP-FLOP; it is the part of the food that gets skewered in SKEWER and it is the part of the petioles that forks the ear in CHERRY. This clear contribution to the overall meaning of the signs makes the use of [web] more a matter of morphology than of lexical phonology. Still, some of the diagnostics we used to determine the phonological status of [web] in LSF offer a positive alternative. [Web] is definitely salient in these signs, and it is hardly expected to enter into an allophonic alternation with neighbouring features. All of these would be akin to false positives, precisely because of the iconic component. If this were all the evidence available, then [web] should

[22]The need for both [radial] and [ulnar] is independently determined – for instance, by signs like NAME (Figure 2c) where the dominant hand requires [ulnar] as the orientation feature while location on the non-dominant hand requires [radial].

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(a) CHINESE (b) CANDY

Figure 19. *The minimal pair (a)* CHINESE *and (b)* CANDY *in ASL.*

not be considered as part of the phonological inventory of this language. Of course, to be exhaustive, one may decide to limit the use of iconic signs as much as possible in identifying phonological contrast in sign languages, as we did in this study.

6.3. Towards parsimonious models of sign language phonology

The account we propose for the distribution of [web] across the various types of signs postulates two identical sets of features, one for use on the non-dominant hand when it serves as a location and the other for the orientation of the dominant hand. In this section, we offer an alternative treatment that avoids this redundancy. Considering that this is the first study addressing the issue, the solution we propose will be highly speculative, although we try to be as precise as possible in our formulation. We look for support in references to what we believe could be comparable phenomena in spoken languages, when possible. The fact remains that the theoretical implementation needs to be tested with empirical facts from more languages. As we did for the analysis in §5, here too we will not frame our proposal within a specific model, although the representation we use draws heavily from the models proposed in Brentari (1998), van der Hulst & Mills (1996), van der Kooij (2002) and van der Hulst & van der Kooij (2021). In fact, we do not intend to replace current models; rather, our proposal should be seen as a module that can be implemented in existing models.

Each body part that serves as a major location has a set of features that constitutes a phonological space where contrast can be created. For instance, in the phonological space provided by the head, contrast can be found between signs produced on the eye or on the cheek, as in the ASL minimal pair CHINESE *vs.* CANDY (Figure 19).

Following the same organisational principle, when the non-dominant hand in asymmetric signs serves as the location for the sign, it must have its own phonological space, and, as we propose in this article, [web] should be part of the features that constitute this space, at least in LSF. The logical consequence of this fact is that [web] serves as a location feature. More precisely, it specifies a narrow location within a broader phonological space. This is the piece of the analysis developed in §5 for asymmetric two-handed signs. The same account, however, cannot be extended when [web] is used on the dominant hand. The reason lies in the hidden assumption that the dominant hand is an active articulator, while location is a passive articulator, and the features used to characterise one cannot be used to characterise the other. To bypass this problem, we propose treating [web] on the dominant hand as an orientation feature.

Although empirically motivated, this move generates a certain amount of redundancy, since the very same feature is now active both in the pool of location features and in the pool of orientation features, as already noted in the preceding sections. In order to account for this issue, it is tempting to assimilate the dual nature of [web] to the [nasal] feature in spoken languages, which can be used to

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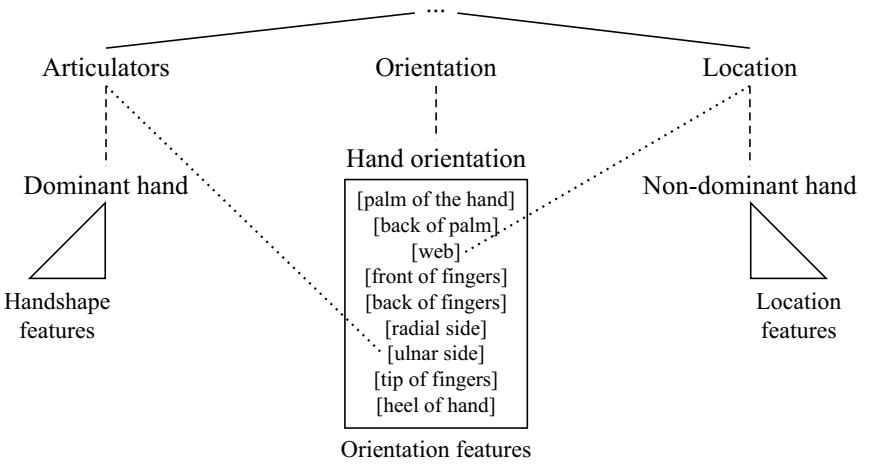

Figure 20. *The representation of orientation in asymmetric two-handed signs. The dashed lines indicate the presence of intermediate nodes and features, and the dotted lines show the association between the relevant nodes and the orientation features. In the case of one-handed and symmetric two-handed signs, the location would be another major body part (for one-handed signs only) or a plane in the neutral space, and an orientation feature would be selected by the dominant hand/articulators only.*

characterise the acoustic and phonological properties of both consonants and vowels (see, e.g., Hajek 2013). However, the redundancy highlighted by [web] is not limited to that one feature. In fact, the whole set of orientation features of the dominant hand is identical to the set of location features of the non-dominant hand when it serves as location, as observed in Brentari (1998). In other words, the problem of the dual nature emerges every time orientation is computed for asymmetric two-handed signs, independent of the specific features involved.

This redundancy can be removed if the sub-specification of locations within each major body part is treated as fully part of relative orientation. For example, [web] would be an orientation feature when it appears on either the dominant or the non-dominant hand. A partial graphical representation of how this implementation works is given in Figure 20, where the dominant hand is associated with the [ulnar] feature, while the non-dominant hand is associated with the [web] feature. Assuming [web] is a viable target, this is the configuration that would yield the orientation observed in EGG-2, PERVERT, PSYCHOLOGY and SHIT in LSF and JANUARY in LIS.

The idea is that orientation features may freely and independently interact with the dominant hand and each node of the location structure. Under this view, orientation features would act similarly to tone features in that they co-occur with other segmental material, while still retaining the ability to mark phonological contrast.

The relative and relational nature of the orientation parameter is thus preserved and made explicit once modelled this way. Formally, orientation can be defined as a function that takes two arguments, a feature stemming from the articulator node and one of the location nodes, and returns the facing relation between the two. A precise formalisation is given in (2):

(2) **Orientation**: $f(a, b) = a$ faces b

a. f is a two-argument function that establishes a facing relation between pairs of features

b. $a \in A$, where $A = \{x \mid x$ is an orientation feature stemming from the dominant hand$\}$

c. $b \in B$, where $B = \{y \mid y$ is an orientation feature and $y \notin A\}$

The broad implications for models of sign language phonology are relatively clear. If our proposal is on the right track, relative orientation is not merely an axiomatic product of the interaction between

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a hand part on the dominant hand and a location. We have provided concrete evidence that this interaction is phonetically and phonologically grounded in how the hand-articulator and location determine saliency on individual orientation features. Models that already implement orientation in this way are superior to models in which orientation is seen as an independent parameter, because the latter models have to introduce additional stipulations to explain the interactions between orientation, handshape and location.

7. Conclusions

In this study, we showed that [web] should be included in the pool of features that contribute to the determination of the phonological inventory of LSF. In contrast to ASL, where descriptively and explanatorily adequate accounts of how lexical phonology uses the webbing can be captured with the [ulnar] feature, the phonology of LSF uses [web] in a contrastive way. We justified the phonological contrast in terms of saliency, near-minimal pairs, word-formation and neutralisation.

We offered an analysis where [web] redundantly serves as a location feature on the non-dominant hand in asymmetric two-handed signs, and as an orientation feature in symmetric two-handed signs and in one-handed signs.

For reasons of economy and elegance, we removed the redundancy of the same set of features serving two independent phonological parameters by proposing that all location sub-specification features should be considered as orientation features, and further that orientation features enter into a dependency relation with the articulator node and one of the location nodes.

Our discussion also tapped into an often neglected aspect of sign language, namely how to determine contrast and what is the specific pool of features that a comprehensive phonological model should include. Our view is that sign language models must specify the architecture and the possible geometries among groups of features, while the pool of active features must be determined by looking at the empirical facts of individual sign languages. There is no gain in limiting the number of features that create contrast. However, parsimony must be used in modelling the set of active features in individual languages. Attributing phonological *vs.* phonetic status to features must be done by taking into consideration the various ways in which contrast is determined in a language.

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