Exploring Movement and Handshape Parameters. A Study on Simultaneous Derivational Affixes in Catalan Sign Language (LSC)*

Aida Villaécija
Universitat Pompeu Fabra
aida.villaecija@upf.edu
https://orcid.org/0000-0002-2981-8485

Gemma Barberà
Universitat Pompeu Fabra
gemma.barbera@upf.edu
https://orcid.org/0000-0003-0669-7243

Elisenda Bernal
Universitat Pompeu Fabra
elisenda.bernal@upf.edu
https://orcid.org/0000-0002-8287-7281

Abstract

Building upon prior lexicalist approaches, this paper explores simultaneous derivation in Catalan Sign Language (LSC). To do so, handshape and movement parameters are examined when functioning as simultaneous derivational affixes in the phonological and morphological interfaces. The study draws upon our manually constructed, non-automated LSC corpus, comprising 456 signs, and follows the integrated morphological model of Villaécija (2023). Like in other sign and spoken languages, LSC exhibits derivational bound morphemes with distinct structures from inflection. Modality allows the integration of multiple morphemes in a non-concatenative way, which demonstrates that in LSC morphological and phonological interfaces are tightly interrelated. This research provides valuable insights into theoretical morphological concepts in sign linguistics and draws parallels with both sign language and spoken language morphology.

Keywords: derivation; affixes; parameters; Catalan Sign Language (LSC)

Resum. *Anàlisi dels paràmetres del moviment i la configuració. Un estudi dels afixos derivatius simultanis en llengua de signes catalana (LSC)*

Partint d'estudis previs amb perspectiva lexicalista (Meir 2004; Aronoff et al. 2005), en aquest article descrivim la derivació simultània en llengua de signes catalana (LSC). Per fer-ho, ens centrem en els paràmetres de la configuració i el moviment quan funcionen com afixos derivatius simultanis en els nivells fonològic i morfològic. L'estudi es basa en el nostre corpus de l'LSC, constituït manualment sense automatització, amb un total de 456 signes, i segueix el model morfològic integrat de Villaécija (2023). Com succeeix en altres llengües de signes i orals, l'LSC compta amb morfemes travats derivatius i estructures que diferencien els afixos derivatius i flexius. La modalitat permet l'articulació de múltiples morfemes simultàniament, amb la qual cosa s'observa que els nivells fonològic i morfològic de l'LSC estan estretament interrelacionats. Aquest article presenta anàlisis clau sobre el comportament morfològic de l'LSC i estableix paral·lelismes amb la morfologia de l'LSC amb altres llengües de signes i orals.

Paraules clau: derivació; afixos; paràmetres; llengua de signes catalana (LSC)

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1. Introduction

The study of morphemes contributes to our understanding of how grammar and lexicon work, and how meaning is structured when creating new words in a particular language. Sign languages are not an exception, and they can also be described and analyzed from a morphological point of view. As natural languages expressed and perceived through a different channel, sign languages also contribute to the characterization of the human faculty of language. In this paper, we study word-formation in Catalan Sign Language (*llengua de signes catalana*, LSC), specifically focusing on derivatives, which may be created either through the addition of a derivational morpheme simultaneously (in a non-concatenative manner) or sequentially (in a concatenative manner). The dichotomy of adding a morpheme either simultaneously or sequentially is found in both sign and spoken languages. Specifically, in sign languages, the addition of a morpheme simultaneously is more productive than sequentially, whether in inflection or word-formation processes (Aronoff et al. 2005; Ribera Llonc 2015). We provide a detailed description of simultaneous derivational affixes in LSC, focusing on the role played by two key parameters, namely movement – the action carried out by the hand or hands, which may involve trajectory – and handshape – the shape adopted by the hand and fingers. The descriptions and analyses of both the derivational affixes and the derivatives themselves are based on the integrated morphological

model (Villaécija 2023), offering an original approach of simultaneous derivation in LSC, particularly in relation to the addition of affixes in a non-concatenative manner to several bases.

LSC is a minority language used by the Deaf[1] and Deaf-blind signing community of Catalonia and Menorca. It is considered that, according to the estimations of the Catalan Federation for the Deaf, LSC is used by around 25,000 people, 12,000 of whom are Deaf or hard of hearing (Quer 2010). As a natural language, LSC has its own grammar and history, which is not analogous to the surrounding spoken languages. It is legally recognized in the Spanish law 27/2007, October 23rd, which regulates the learning, knowledge and use of two sign languages in Spain, namely Spanish Sign Language (LSE) and LSC. It is also officially recognized in the autonomic Catalan law 17/2010, June 3rd, as an integral part of the linguistic and cultural heritage of Catalonia. At a global scale, the linguistic research on sign languages only began in the second half of the 20th century but until now the body of research is not yet comparable to that of spoken languages.

The fundamental distinction between sign languages and spoken languages lies in the channel of expression and perception, typically known as 'modality'. While spoken languages use the vocal-auditory modality, sign languages use the visual-gestural modality, as they are perceived by sight and expressed with manual and gestural movements on signing space. Sign language signs are featured by two manual articulators, as well as non-manual articulators like the different parts of the face, the head, and the upper torso. This multiplicity of articulators allows the linguistic message to be expressed simultaneously with different non-manual markers as well as the two hands, but also sequentially with strings of signs attached one after the other.

Morphology is an open field of research in the sign language literature. Traditionally, there has been a tendency to analyze signs from a phonological and syntactic perspective, without considering operational rules of morphological construction. Starting from the view of studies with a more lexicalist approach (Aronoff et al. 2005), supporting with approaches of formal morphology for spoken languages (Corbin 1991a, 1991b) and complementing with a prosodic model based on sign language (Brentari 1998), we aim to define the rules of derivational constructions in LSC that allow the formation of new signs, something that, to our knowledge, has not previously been done for other sign languages. To do so, we need to delve in the distinction between phonemes and morphemes and the corresponding interface in LSC, as shown in the next section.

The rest of the paper is organized as follows. Section 2 describes the phonological and morphological interface in sign languages. Section 3 presents the methods of the paper. First, it develops the integrated morphological model that grounds the theoretical framework (3.1) and then it explains the data set and annotation used in this research (3.2). Section 4 focuses on the description

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1. We adopt the common convention of capitalizing the term *Deaf* to refer to individuals who identify with the culture belonging to Deaf signers and who consider themselves part of a linguistic and cultural community.

and analysis of the simultaneous affixes in LSC, by concentrating first on the movement parameter and afterwards on the handshape parameter. Section 5 discusses the central ideas and contributions. Finally, section 6 concludes the main findings and outlines prospective lines of research.

2. Phonological and morphological interface in sign languages

Signs are not holistic elements and, like words, they have an internal structure. They are made up of minimum units known as formative or phonological parameters. A parameter constitutes a fundamental group of features, similar to possible segment types in spoken languages (e.g., vowels, glides, obstruents, approximants) (Fenlon et al. 2017). The combination of these parameters, which may be both simultaneous and sequential, creates signs. Phonemes in signs, like in words, cannot occupy all the positions within a combination and therefore some combinations are not grammatically possible.

Parameters in sign language may be distinguished between manual and non-manual. Manual parameters are formed by handshape, place of articulation, movement, and orientation. Non-manual parameters include facial expression, movement of the torso, head position and/or movement, mouth gesture, and mouthing. Non-manual parameters may not be specified for some lexical signs. In Figure 1 below the sign PERSON is illustrated. The handshape, which refers to the shape adopted by the hand and it is mainly defined by the position of the fingers, is ∟ , with the thumb and the index fingers selected and flexed.[2] The place of articulation refers to the specific location in which the sign is articulated, which in PERSON is at the frontal plane in front of the signer. The movement is defined as the action carried out by the hand or hands and it may involve or not a trajectory within the signing space. The example of PERSON has a downward movement. Finally, the orientation is defined as the direction of the palm and the fingers, being forward in Figure 1. The sign PERSON does not have a non-manual specified.[3]

It is important to note that a distinction is made between the two manual articulators. The dominant hand refers to the hand that is more active in the articulation of the sign, while the non-dominant hand is the one that is less active or not used at all in one-handed signs. For right-handed signers the dominant hand is the right one, and for left-handed signers it is the left one. As will be shown below (section 4.1), morphophonological analyses apply similarly for both right- and left-handed signers, because we are dealing with dominance rather than handedness.

The justification for phonological parameters as being feature units derives from their ability to show contrasts. For example, in LSC the sign TO-WORK differs from ALWAYS solely along the handshape dimension, as shown in Figure 2. While the handshape for TO-WORK is ○, the handshape for ALWAYS is ⌐ . In both

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2.   The font style used in this paper for representing the handshapes of signs is Handshape2002, which was created by the Centre for Sign Linguistics and Deaf Studies. It is open access and can be downloaded at <http://www.cslds.org/v4/>.

3.   If not stated otherwise, the images used in this paper are sourced or adapted from Villaécija (2023).

Figure 1. PERSON

a. TO-WORK   b. ALWAYS

Figure 2. Handshape contrast (images adapted from Dilscat (Illescat 2004))

signs the rest of manual parameters (place of articulation, movement and orientation) are the same. Therefore, TO-WORK and ALWAYS constitute minimal pairs (Quer et al. 2005) and the particular features of each handshape do not add any meaning to the root. The handshape parameter has only been studied in LSC as a morpheme within word families (Villaécija 2022, 2023).

Pairs of contrasts along the movement parameter are also found. Movement is the action carried out with the hand(s), which can be categorized into two types. On the one hand, with path movement, that is with displacement of the hand from one place of articulation to another and signed through the elbow and the shoulders. On the other hand, without path movement, that is articulated at the same place of articulation and signed with the joints of the fingers, the knuckles and wrists movements (Sandler & Lillo Martin 2006). Another example of minimal pairs in LSC along the movement dimension is formed by the pair shown in Figure 3. The movement for TO-WAIT is beating, whereas the movement for AUGUST involves a short rotation of the wrist. The rest of the parameters stay the same.

So far, parameters have been defined at the phonological interface, yet they also play an important role at the morphological level. In fact, the alteration of

a. TO-WAIT   b. AUGUST

Figure 3. Movement contrast (images adapted from Dilscat (Illescat 2004))

certain phonological aspects of a morpheme has been extensively investigated in sign languages, and it is defined as the most recurrent and productive form in terms of inflection and lexical formation. This phenomenon arises because lexical units tend to be monosyllabic and encompass more than one morpheme simultaneously (Aronoff et al. 2005; Ribera Llonc 2015).

In sign languages the morphological and phonological interfaces are tightly interrelated. This is exemplified in certain inflected and derived processes in LSC, where phonological rules are directly applied to the lexicon (Padden & Perlmutter 1987; Ribera-Llonc et al. 2019, among others). For instance, in LSC the movement parameter may serve various morphological functions, namely number, verb agreement and distinction between lexical categories. In what follows, we will focus on each function.

An example of a movement morpheme expressing number is exemplified below in the verb TO-GIVE. The singular form of this verb exhibits a single straight movement, whereas its plural form is expressed by adding a path movement (Quer et al. 2005). Moreover, depending on the type of path movement, different plural forms can be distinguished. Figure 4 illustrates the two types of plural forms in TO-GIVE. The collective plural is conveyed through a continuous path movement, glossed as TO-GIVE-arch (Figure 4a), while the distributive plural is represented by a beating path movement (repeating the sign three times in the horizontal x-plane), glossed as TO-GIVE+++ (Figure 4b).

These cases are also examined in terms of reduplication, because adding path movement to a sign is also a way of repeating a lexical item. The two sentences below illustrate the use of this morpheme, when denoting the collective plural, expressed with arch movement (1), or the distributive plural, expressed with beating path movement in a reduplicated form (2) (Quer et al. 2005). While in (1) the path movement expresses the repetition of the action with all the objects, triggering a cumulative reading, the reduplication in (2) conveys the meaning 'give to each one', activating the action with singleton objects.
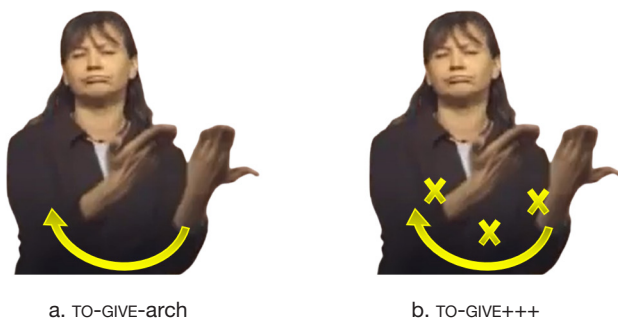
a. TO-GIVE-arch   b. TO-GIVE+++

Figure 4. Collective and distributive plural, adapted from Quer et al. (2005)

(1)   TOCA[4] CHRISTMAS IX1 ALL FAMILY IX1 BOOK **TO-GIVE-ARCH**.
       'For Christmas, I'll get books for all my family.'
(2)   TOCA CHRISTMAS ALL FAMILY ONE ONE ONE BOOK **TO-GIVE+++**.
       'For Christmas, I'll get a book for each member of my family.'

Additionally, the direction of movement functions as verb agreement in LSC, similar to other sign languages. Some agreement verbs may modify the direction of their movement feature, and occasionally the orientation of the palm or fingers as well, to express subject and object. For instance, consider the directional verb TO-EXPLAIN (Figure 5). When the subject is the first grammatical person and the object the second person, the direction of the verb has a forward movement, glossed as 1TO-EXPLAIN2 (Figure 5a). However, when the subject is the second person and the object is the first person, the direction of the verb has a backward movement, glossed as 2TO-EXPLAIN1 (Figure 5b).

a. 1TO-EXPLAIN2   b. 2TO-EXPLAIN1

Figure 5. Agreement verb movement, adapted from Institut d'Estudis Catalans (2024)

4.   The gloss from the LSC sign TOCA is left in Catalan since it conveys spatial and temporal coincidence and does not have an exact translation into English.

Considering simultaneous derivation, noun-verb pairs may be distinguished based on the type of movement too. Such an example in LSC is SCISSORS / TO-CUT, where the noun exhibits a simple movement while the verb is reduplicated (Ribera Llonc 2015; Ribera-Llonc et al. 2019). Movement can therefore also function as a bound morpheme to create derivatives. Within this framework, simultaneous derivation is characterized by non-concatenative morphology, wherein phonological material is associated with an abstract prosodic form (Klima et al. 1979; Padden & Perlmutter 1987).

While previous research has provided insights into inflection in LSC (Quer et al. 2005), the study of movement has predominantly focused on its role as a bound morpheme in inflection rather than its involvement in word-formation processes. The only study of the movement parameter in LSC is related to reduplication for noun-verb pairs (Ribera Llonc 2015; Ribera-Llonc et al. 2019), but there remains a significant gap in the literature concerning the highly-iconic parameter of handshape and movement in the means of derivation as a productive bound morpheme. Thus, this paper aims to address this gap by studying the phonological and morphological interfaces of handshape and movement in LSC, with a specific focus on the process of derivation.

3. Methods

This study adopts a corpus-driven approach and employs qualitative methods, as presented in section 3.1. The analysis of derivatives through these parameters relies on a morphological examination of simultaneous features within a lexicalist and morphophonological framework, as elaborated in section 3.2.

3.1. Data set and annotation

Being a natural minority language, LSC still lacks available resources for research purposes. The data for this study was gathered and revisited from Villaécija's corpus (2023), which comprises a total of 456 LSC signs. These signs were manually extracted from various LSC resources, including videos of natural signed discourse, teaching materials, dictionaries and glossaries. The extraction of lexicon followed a semantic approach, focusing on content signs with complex structures. For annotation, the ELAN software (2024) was used, which allows synchronizing videos with annotations. Afterwards, the data was managed and processed using Excel, where every parameter from the theoretical integrated model was established through manual (not automated) analysis. An example of an annotated sign is provided in Table 1.

The annotated tabs refer to each parameter of a sign, based on the integrated morphological model explained in the following section. The categories provided in this paper emerge naturally from a cross-analysis of the data. The corpus is published online and is freely available for research purposes.[5]

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5.   Click here or paste <https://shorturl.at/nJNRS> in your browser's address bar to access the corpus.

Table 1. Annotated sign example

Parameter	Example
Reference	IEC_BDD
Annotation time	0:01:14.47
Sign	DIFFERENT
Handshape	1 (Ⓑ)
Handshape 2	-
Aperture	no
Semantics	reduplicated
Place of articulation	horizontal plane (x)
Point(s) of articulation	[central]
Body contact	non-dominant hand
Movement	wrist rotation
Orientation	back-forth
Non-manual component	yes
Mouthing	no
Eyes / eyebrows	no
Mouth / tongue / teeth	opened mouth
Cheeks	no
Non-dominant hand	yes
Handshape	1 (Ⓑ)
Handshape 2	-
Aperture	no
Semantics	reduplicated
Place of articulation	horizontal plane (x)
Point(s) of articulation	[central]
Body contact	non-dominant hand
Movement	wrist rotation
Orientation	back-forth
Comments	Related to DIVERSITY

3.2. Morphological analysis: integrated morphological model

Signs from the annotated corpus underwent an analysis to identify and categorize morphological phenomena, considering the phonological and morphological interfaces. These phenomena encompass inflectional (grammar-related) and derivational (sign formation) processes. The analysis adheres to the integrated morphological model (Villaécija 2023), which combines five models and theoretical approaches, summarized in what follows:

— The prosodic model (Brentari 1998), which conceptualizes the phonological structure of sign language in general and applies it to American Sign Language (ASL). It provides the inherent and the prosodic features of a sign, both simul-

taneous and sequential, and connects them according to their functions and dependency.
— The use of grammatical signing space (Barberà 2015), which defines the three areas of the tridimensional space, the horizontal (x), frontal (y) and midsaggital (z) plane and proposes a grammatical correlation with the different areas within. The horizontal plane is perpendicular to the body of the signer and may be divided into [ipsi] – in line with the surrounding of the dominant hand and shoulder –, [contra] – in line with the surrounding of the non-dominant hand and shoulder – and [central] – in line between [ipsi] and [contra] in front of the signer. The frontal plane extends parallel to the body of the signer and is divided into [superior] or [inferior] accordingly. The midsaggital plane is articulated vertically and perpendicular to the body of the signer, considering [prox] – the area closest to the signer – and [distal] – the area farthest from the signer.
— The generative lexicalist model (Corbin 1991a, 1991b), which formulates the rules of generic and oriented constructions. It allows categorizing the lexicon and its components, as morphological operators (affixes) and bases.
— The previous research on natural languages grammaticalization (Meir 2004; Aronoff et al. 2005; Janzen 2012), which argues that in sign languages, as in spoken languages, free grammatical components (pronouns or adverbs) or dependents (affixes) can be formed from free components (nouns or verbs).

According to the integrated morphological model, LSC signs consist of phonemes and morphemes, categorized according to their phonological or morphological properties. Parameters are studied at the same level of relevance, both simultaneously and sequentially. Generally, signs and morphemes form a continuum of grammaticalization, with some showing greater grammaticalization than others. The model adopts a generativist perspective, as it posits rules of construction that differentiate the bases from attached morphemes. The morphological analysis focuses on the base as the main node, which comprises simultaneous inherent features (handshape, place of articulation and orientation parameters) and sequential prosodic features (parameters related to movement). While inherent features remain constant, prosodic features may vary. Thus, prosodic features represent a sign's movement and its interaction with other parameters, which includes trajectory in signing space (path movement), aperture (fingers opening or closing) and setting (linking complex movements and handshape or orientation change). The analysis tree is displayed in Figure 6.

The base consists of several simultaneous and sequential parameters (in Figure 6, parameters A, B, C, etc., representing handshape, movement, orientation, etc.). The tree branches into dependent constituents, including a base with phonemes and bound morphemes, and formulates generic and oriented construction rules, if applicable. In essence, the analysis determines whether a sign has been formed compositionally.
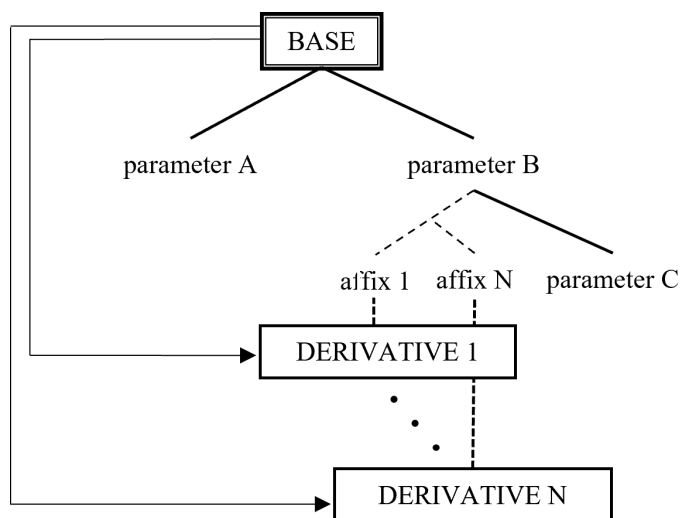
Figure 6. Integrated morphological model (Villaécija 2023)

4. Simultaneous affixes in LSC

Simultaneous derivation in LSC involves the addition of an affix to a base in a non-concatenative manner to create a new sign (section 2.2). Handshape and movement are analyzed in the morphological-phonological interface, within the integrated morphological model (section 3.2). Accordingly, this section is divided into two subsections. Subsection 4.1 corresponds to the description of the movement affix, while subsection 4.2 aligns with the handshape affix. Both subsections include the categorization of derivatives with each affix attached to them and their role in forming derivatives in LSC.

4.1. Movement

The movement parameter in the morphological interface is highly productive in LSC, as will be shown through the analysis of derivation. According to our corpus analyses, two different types of movement affixes create derivatives in LSC. On the one hand, the path may include various features like distal or proximal, linear, and arch. On the other hand, the circular movement may include other features (see Fig. 7). Both types of movement (path and circular) are added simultaneously to a base to create signs with new and constant meaning, such as EQUAL / EQUALITY, where the base EQUAL has a simple movement, and the derivative EQUALITY adds a path movement to the base. However, the circular movement affix can also be attached in a non-concatenative manner by altering the disposition of the sign, as shown in FACTORY / TO-PRODUCE. While FACTORY has a circular forward movement, TO-PRODUCE moves from [ipsi] to [central] sides of signing space. Generally, the addition of the movement affix implies that the base is being duplicated or reduplicated.
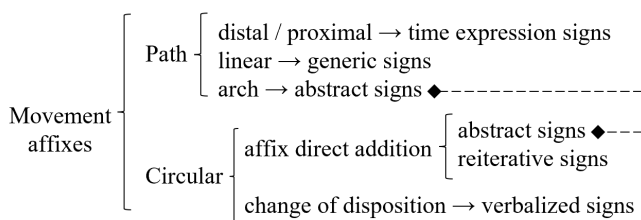
$$
\text{Movement affixes}
\begin{cases}
\text{Path}
\begin{cases}
\text{distal / proximal} \rightarrow \text{time expression signs} \\
\text{linear} \rightarrow \text{generic signs} \\
\text{arch} \rightarrow \text{abstract signs} \blacklozenge\text{-------------}
\end{cases} \\
\text{Circular}
\begin{cases}
\text{affix direct addition}
\begin{cases}
\text{abstract signs} \blacklozenge\text{---} \\
\text{reiterative signs}
\end{cases} \\
\text{change of disposition} \rightarrow \text{verbalized signs}
\end{cases}
\end{cases}
$$

Figure 7. Outline of the analyzed movement affixes

Movement affixes include different forms that convey different functions and meanings. This is summarized in Figure 7, which outlines a classification of the derivatives for each type of affix.

The path movement affix may have different forms, such as distal or proximal, linear or arch, and correspondingly it creates time expression derivatives, as well as generic and abstract signs. As for the circular movement affix, it can be directly attached to a base to create abstract and reiterative signs, or it can be expressed by altering the movement disposition to create verbalized signs. As depicted by the black dashed line of Figure 7, the path and circular movement affixes are intricately related, as they both create abstract signs with similar structures and behaviors.

The abstract representation for each type of movement affix in LSC is given in Figure 8.[6] The gray-colored semicircles represent the prototypical horizontal plane of the signer, and the symbols in them ($\otimes$) indicate the points of articulation, that is, where the sign is articulated. The arrows connecting these points represent the axis of the abstract movement affixes.

Figure 8a, b, and c illustrate the three types of path movement affixes, which trace the abstract shapes of a line or an arch. The affix for distal or proximal path movement is articulated based on the proximity of the signer's hands. It moves from a distant location of the signer [distal] to a nearer one [prox], or from a near location or in contact with the signer [prox] to a distant one [distal]. The linear path movement affix is articulated with both hands from one point to the other: the non-dominant hand moves from [central] to [contra] and the dominant hand from [central] to [ipsi], each hand moving in opposite directions. The arch movement affix articulates the sign into three points of articulation, starting from [contra], moving to [central], and finishing in [ipsi] with regards to the signer's points of articulation, or the other way around. Figure 8d shows the circular movement affix, which is abstractly located in front of the signer in the horizontal plane, at the [central] point of articulation. Whereas path movement has a minimum of two points of articulation, circular movement has just one. This is due to the fact of path movement having a trajectory in signing space.

Distal and proximal affixes create time expression signs when attached to a base, usually adverbs. These derivatives are located in the midsagittal plane and

6.   The disposition of the movement affixes can change according to the context and other inflection processes. The illustrations offer an abstract representation.
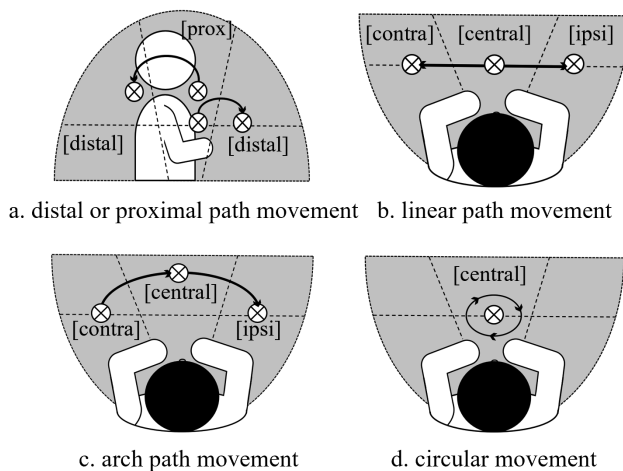
a. distal or proximal path movement   b. linear path movement

c. arch path movement   d. circular movement

Figure 8. Representation of movement affixes

are strongly related to the representation of time, considering the signer's position. The derivative maintains its base's inherent features but differs in prosodic features since the affix is added. Consider the derivative pair TOMORROW / THE-DAY-AFTER-TOMORROW (Figure 9).

The derivative THE-DAY-AFTER-TOMORROW maintains the same parameters as the base TOMORROW: one articulator, B-handshape, optional non-manual markers, and orientation with supination. The path movement affix is attached, and the final disposition of the duplicated segment is changed. The internal complex movement of the base – the wrist rotation by supination – is maintained because it is inherently part of the sign to articulate it correctly. If the internal movement of the base were not articulated, along with the rest of inherent features of the base, the derivative would be ill-formed. The morphological analysis of TOMORROW / THE-DAY-AFTER-TOMORROW is illustrated in Figure 10.
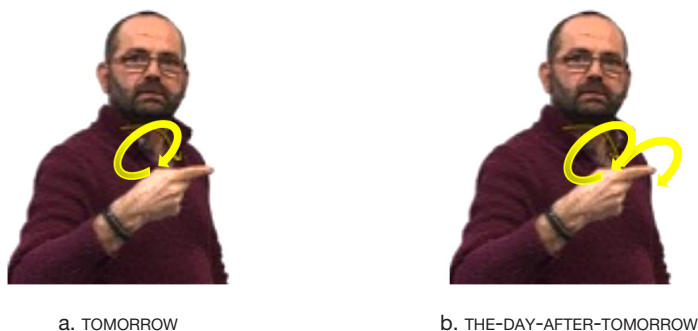

a. TOMORROW   b. THE-DAY-AFTER-TOMORROW

Figure 9. Derivative pair with distal movement affix, adapted from Frigola (2021)
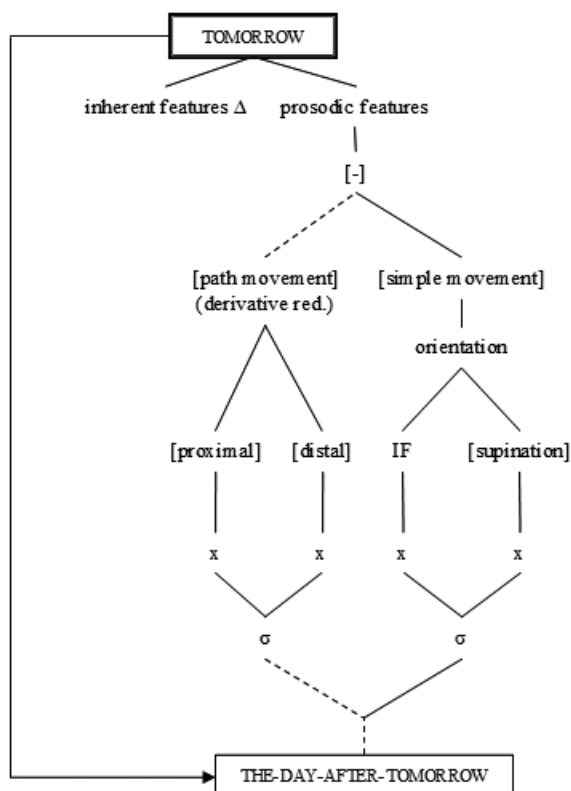
Figure 10. Morphological analysis of TOMORROW / THE-DAY-AFTER-TOMORROW

The main node is the base, which is made up of various parameters in the inherent features – one dominant hand articulated with Β-handshape and supination. The base is monosyllabic, as expressed with the sigma letter (σ). The black dashed line in the prosodic features of the base shows the addition of the affix path movement, which implies that the sign is articulated again (as derivational reduplication). Therefore, one more syllable is added, as well as one more point of articulation. It starts from the base last point of articulation and ends at [distal]. Due to the addition of the derivational morpheme, the sign is repeated in two locations on the midsagittal plane. The addition of the affix can be studied within the means of reduplication. However, the repetition of the movement itself cannot be considered as an affix, as the sign would be ill-formed.

The use of space in this type of derivatives has semantic implications in discourse analysis. In sign languages, time expression signs are grouped on different spatial axes (Engberg-Pedersen 1993; Arik 2012; Barberà 2015; Frigola 2021). The reference point is the present, located right in front of the body of the signer. Then, depending on the direction of the path movement along the midsagittal plane, the

sign refers to the future – when moving forward – or to the past – when moving backward –, as illustrated in Figure 11.

Other derivative pairs of this kind are distinguished in our corpus, such as YES-TERDAY / THE-DAY-BEFORE-YESTERDAY or YESTERDAY / PAST (LSC). They all share the same morphological structure, where the affix provides a constant meaning and follows the same pattern.

Path and circular movement affixes create abstract and generic signs when attached to a base. The base exhibits simple movement, and when the affix is simultaneously attached, the base is reduplicated, either with a circular or a path movement. Consequently, abstract and generic derivatives formed by path movement imply the addition of two more points of articulation to the base: [contra] and [ipsi]. Abstract derivatives embody signs with an inner complex structure: the path or circular movement is added to a base to create a sign denoting intangible ideas. Generic signs are constructed similarly but with a linear movement, and the resulting derivative possesses a generic meaning that can be perceived or sensed. For example, consider the base EQUAL and the abstract derivative EQUALITY, which is formed through the addition of the path movement affix (Figure 12).

This derivative pair is analyzed in Figure 13 using the morphological model. Once again, the base has inherent features that the derivative entirely inherits: Ɓ-handshape, straight movement with each hand in contact with the other, and [central] point of articulation. The pair only differs in the prosodic features, as the path movement affix is attached to EQUAL. In the morphological interface, the base is a
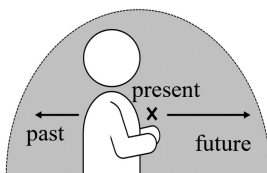

Figure 11. Temporal axis in LSC

a. EQUAL   b. EQUALITY

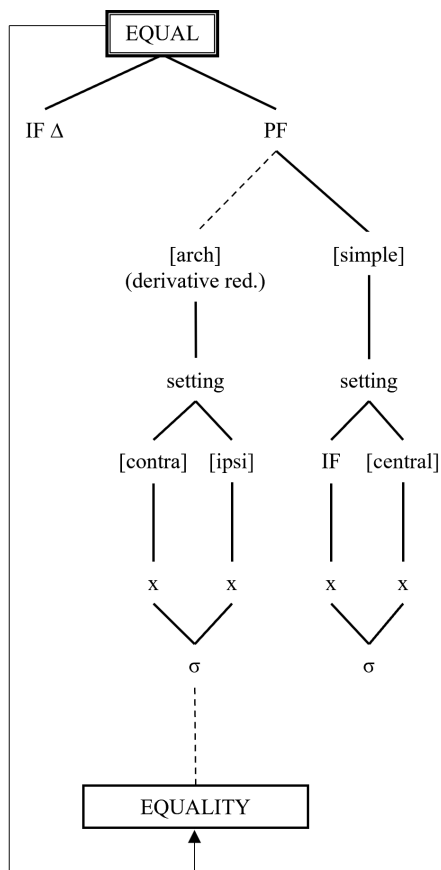**Figure 12.** Derivative pair with arch movement affix, adapted from Institut d'Estudis Catalans (2024)

Figure 13. Morphological analysis of EQUAL / EQUALITY

free simple morpheme, a combination of different parameters, while the derivative is structurally complex: the base with a derivational morpheme altogether. Thus, the phonological interface of both signs is also distinguished since the affix is added in a non-concatenative way.

Regarding the use of the derivative, (3) presents a sentence with the abstract derivative EQUALITY. In (3), the subject is the derivative created through the addition of a path movement to EQUAL. In contrast to its base, the derivative means 'a social situation in which everyone has the same rights and opportunities, both culturally and socially'. Thus, the path movement adds new and abstract meaning to the base and creates a new lexeme.

(3)   IMPORTANT FOR WORLD BETTER ACHIEVE WHAT? **EQUALITY** SPECIFIC.
      'Equality is important to achieve a better world.'

As noted before in section 2, the path movement in the morphological interface can also express number. The same base with path movement can, on the one hand, create the derivative EQUALITY and, on the other hand, express number too, glossed as EQUAL-arch. However, in this case, it does not add new meaning to the base but provides grammatical information. For instance, sentence (4) illustrates an example of EQUAL with the arch movement inflected affix.

(4)   IX DIFFERENT FREE CLOTHES COLOUR CLOTHES SCHOOL SHARE **EQUAL-ARCH**
      CLOTHES DIFFERENT EQUAL NO.
      'We didn't have to dress the same way at school.'

When the arch movement derivational affix cannot be distinguished phonologically from the inflectional affix, the semantic meaning and structure must be considered. While the sentence given in (3) clearly denotes a new lexeme created from a base, in (4) the meaning of the sign with the affix is the same as the base but expressed in plural form. This affix productively creates abstract derivatives and provides a constant meaning to different bases, as demonstrated in our corpus, with examples of pairs like BROTHER / SOLIDARITY, SISTER / SORORITY, among other cases. In this sense, circular and path movements are closely interrelated, as the same derivative can be expressed either by the circular or the path movement. For instance, the abstract derivative SOLIDARITY can be formed by both the addition of the circular or the path movement affix, as shown in Figure 14.

On the other hand, generic derivatives are common nouns that have undergone a morphologically complex process. Initially, they are not semantically similar and differ from their base by their phonological parameters, context, and structure. Generic signs can only be constituted through the addition of the linear path movement, as in SPECIFIC / SIMPLIFICATION (Figure 15).

The base is bimanual, with a simple movement not anchored to the signer's body. The handshape is ○ and there is no trilled movement. When the linear path movement affix is attached to it, the derivative SIMPLIFICATION is created. The derivative is bimanual like its base and inherits all its parameters, except for the
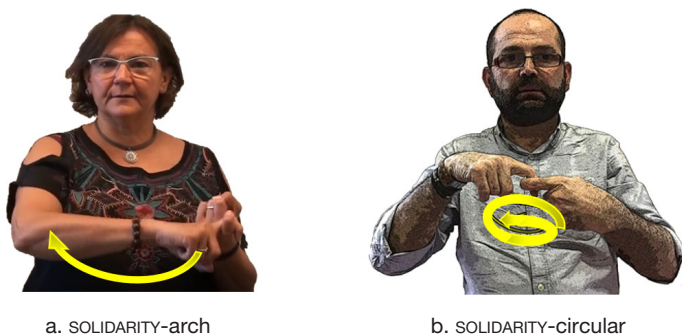

a. SOLIDARITY-arch   b. SOLIDARITY-circular

Figure 14. Derivative with arch and circular movement affix, adapted from Frigola (2021)

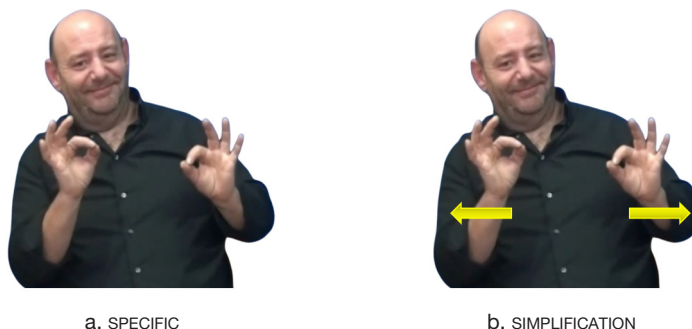a. SPECIFIC   b. SIMPLIFICATION

Figure 15. Derivative pair with linear movement affix (Institut d'Estudis Catalans 2023)

movement, which is modified due to the addition of the affix. In this case, a linear path movement to [contra], articulated by the non-dominant hand, and to [ipsi], by the dominant hand, is added. The derivative starts in the place of articulation of the base, which is [central]. The pair is monosyllabic, but the inner structure differs, both in the phonological and the morphological interface.

Additionally, phonological alternation can be found in generic derivatives, specifically the hand-addition. This implies that derivation adds the other manual articulator to the derivative, namely the non-dominant hand, which is not found in the base, as shown in TREE / FOREST (Figure 16). The derivative FOREST is articulated with two manual articulators: the dominant hand and the non-dominant hand, while the base TREE is monomanual. Moreover, the trilled movement of the base is also modified by the derivational process. The derivative only performs a single rotating movement of the wrist at the beginning of the articulation of the sign.

Besides, the derivative clearly differs from the plural form TREE+++ or the corresponding whole entity classifier[7] due to the change in meaning, to the context, and to phonological parameters, as shown in (5) and (6), respectively.

(5) BEAUTIFUL **FOREST** WORLD IX-rep ENDING.
     'You are the most beautiful raven in all the forests of the world.'

(6) STONE STATUE TREE **CL-TREE+++**.
     'The statue is surrounded by trees.'

The derivative in (5) refers to a large area covered with trees and undergrowth, which may have a variety of flora and fauna and is often a natural habitat for wildlife. In contrast, the plural form in (6) does not introduce any new meaning apart from providing grammatical number information and indicating spatial location. In the morphological interface, (6) indicates the location of the trees in relation to the

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7.   A classifier is a complex predicate morpheme with a highly iconic value that reproduces visual features of situations, actions or objects. It is very frequent across sign languages and it is used for the description, handling or representation of a referent and to express motion or location (Quer et al. 2005).
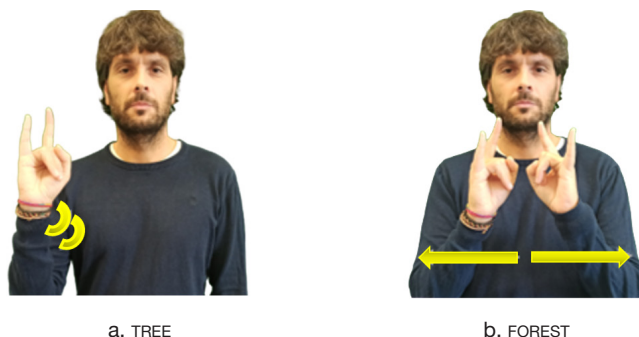
a. TREE   b. FOREST

Figure 16. Hand-addition with linear movement affix

referent STATUE, which is anchored in the sentence by the non-dominant hand. As mentioned earlier, the derivative FOREST involves a single rotating wrist movement in the horizontal plane, while TREE+++ does not have any wrist rotation. Instead, it has a repetitive movement for each repetition in space. However, it is important to note that before the classifier, the noun tree is signed first as an antecedent with all the features of the sign, including the wrist rotation.

Regarding the circular movement affix, two different ways of adding it to a base are distinguished. Firstly, through the traditional addition in a non-concatenative way (as described before with path movement), such as TO-HIT / TO-ABUSE. Secondly, through the change of the sign's disposition with a circular movement, as in FACTORY / TO-PRODUCE.

The derivative pair TO-HIT / TO-ABUSE is formed by the addition of the bound morpheme in the traditional way, and the affix has the phonological representation of a circular movement. This affix adds the idea of repetition in an undetermined and consecutive manner to the action expressed by the base. The negative meaning, then, is inherited from the base instead of the affix. The derivatives created through this affix are native signs that can function as a verb or as a noun. The use of TO-HIT / TO-ABUSE is compared below.

(7)   IX2 PERSON SMOKE IX2 NUN A-LITTLE **TO-HIT**.
      'If you smoked, the nun would beat you.'

(8)   EVERY-DAY CL-HANDLING-VOLUME HAVE-TO WHAT STAIN **TO-ABUSE**.
      'Every day she checked if we had stained our clothes. She abused us.'

The base in (7) means a violent physical contact, whereas the derivative in (8) stands for a continuous negative situation of abuse and violence, either physical or psychological. In (7) the base is a free morpheme consisting of a group of parameters and works as a lexeme. In (8) the derivative is also a free morpheme, but it possesses an inner complex morphological structure: a base with a bound morpheme attached to it, adding a constant new meaning to the base. The derivative pair is illustrated in Figure 17.

a. TO-HIT   b. TO-ABUSE

Figure 17. Derivative pair with circular movement affix

Lastly, a specific derivative pair is distinguished in the corpus: FACTORY / TO-PRODUCE. The circular movement affix is added through the change of the base's disposition. In this case, the direction of the circular movement serves as a simultaneous affix of verbalization attached directly to a nominal base. Unlike the circular movement directly attached to a base, it does not add any reiteration value but instead brings about a change in the grammatical category: turning a noun into a verb. Semantically, the base FACTORY denotes 'a place or establishment where goods are produced and raw materials are processed', while the derivative refers to the action that arises from it, 'the action of producing goods and processing raw materials' (Figure 18).

Regarding the phonological structure of the base, FACTORY can be signed both mono- and bimanually; and the dominant hand articulates the > -handshape. The feature of the non-dominant hand is shown in parentheses because it is optional. In Figure 19 the morphological analysis of this pair is presented.

The base FACTORY cannot be divided into smaller morphological units given that it is a combination of inherent and prosodic features, essentially a group of phonemes. From the two manual articulators of the base, for the formation of the
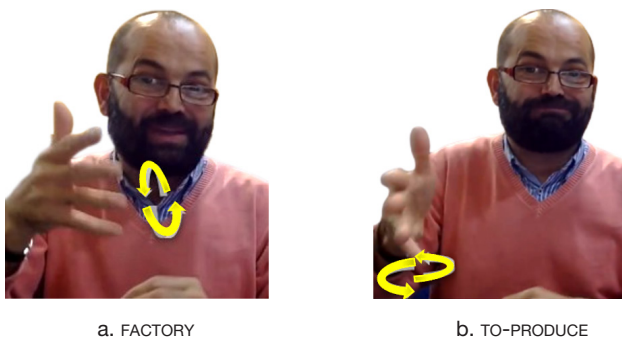

a. FACTORY   b. TO-PRODUCE

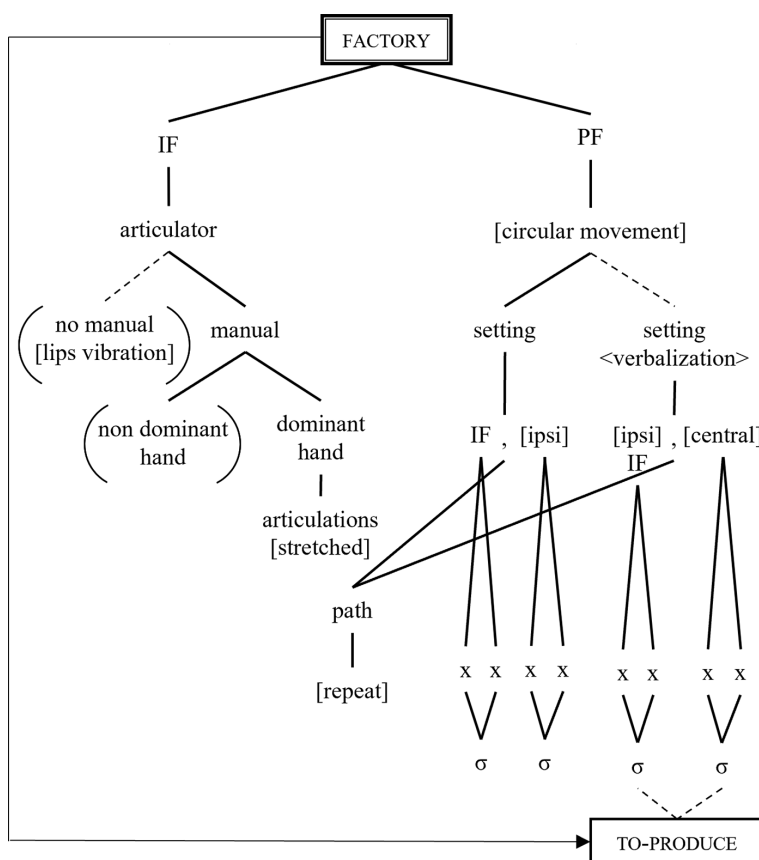**Figure 18.** Derivative pair with circular movement affix

Figure 19. Morphological analysis of FACTORY / TO-PRODUCE

derivative TO-PRODUCE, only the mandatory dominant hand is preserved, representing the minimal morpheme of the base. The parameter that must be modified to form the derivative is the movement feature. While the base is characterized by a forward movement on [ipsi], the derivative has a lateral movement from [ipsi] to [central]. The syllabic weight may also be phonologically altered.[8] Optionally, the derivative may also co-occur with a lip-vibrating non-manual component, as indicated in the analysis in parentheses (Figure 19).

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8.   The number of syllables does not vary, but it is possible, according to Deaf experts, that TO-PRODUCE is articulated with more than two syllables, unlike the base, which is signed only in two syllables.

4.2. Handshape

In the morphological interface, the handshape can be found as a bound morpheme in classifiers and derivatives. In derivation, this parameter is productive and adds the constant meaning of opposition to the base. It is added in a non-concatenative way and is studied within the process of grammaticalization. Consider the derivative pair LAW / CRIME in Figure 20.

LAW is a non-built complex sign, given that the non-dominant hand's handshape is a free morpheme that functions as a base for some classifiers, such as <flat entity or volume>. It is complex from both a structural and a semantic point of view, but it does not have any affix or free morpheme attached to it. In fact, the morpheme <flat entity or volume> allows the formation of initialized signs, like the simultaneous compound ARTICLE or those initialized from the same sign family CONSTITUTION / STATUTE / REGULATION (Villaécija 2022, 2023).

Semantically, the base LAW refers to a rule or a set of rules established by a government or authority that must be complied with. When the D-handshape affix is attached, the sign acquires a new derived meaning, CRIME, which refers to any act or omission that is prohibited by law and punishable by the government or authority and may lead to a penalty or have judicial repercussions. All features of the base are inherited, except for the handshape, which is modified as part of the simultaneous derivational process in the morphological interface. The addition of the affix is highlighted in the analysis in Figure 21 by a dashed line.

As shown in Figure 21, in the formation of the derivative CRIME, the inherent and prosodic features of the base are maintained. The same articulators are selected, and the sign is arranged in two points of articulation, from [upper] to [lower]. It has path movement with [supination] of the wrist, which ends in contact with the non-dominant hand [direction: >|]. The D-handshape affix is attached to these features, adding the constant meaning of opposition. Specifically, it is added in the aperture of the handshape, in the prosodic features, linked to the articulation of the dominant hand's selected finger.

In this case, the meaning of opposition conveyed by the affix is integrated to form the derivative in the second mora of the base LAW, positioned is at the [lower] point of articulation, precisely where the syllabic weight of the sign lies. This process begins with the base, which can be a noun or an adjective, to which the opposition D-handshape affix is simultaneously attached. This affix is examined

a. LAW   b. CRIME

Figure 20. Derivative pair with D-handshape affix

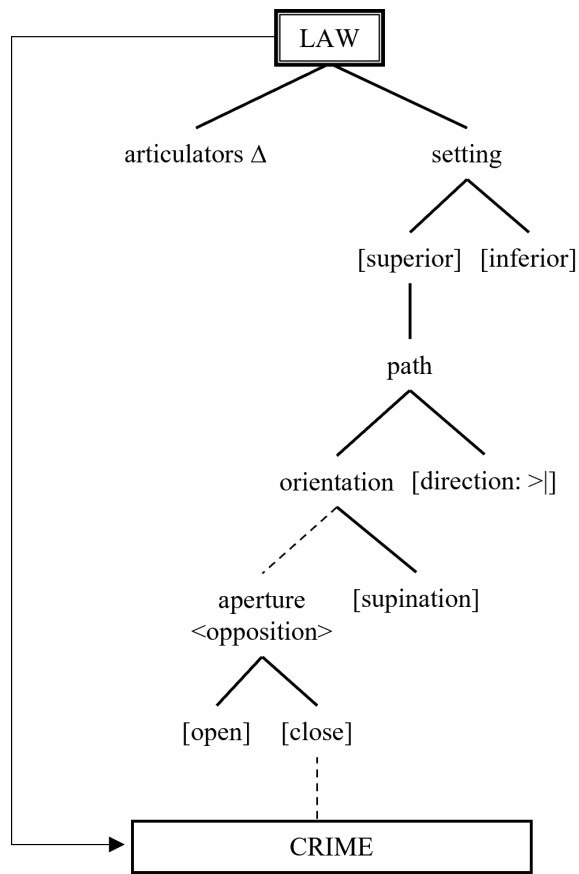within a continuum of grammaticalization (Villaécija 2024), having evolved from the free morpheme AGAINST (Figure 22).

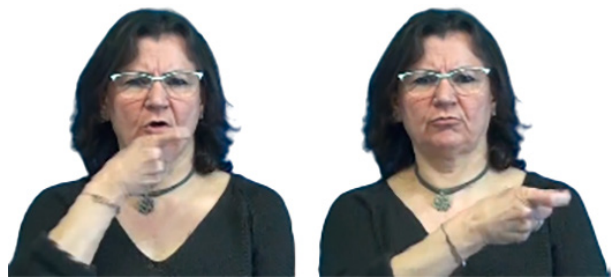**Figure 21.** Morphological analysis of LAW / CRIME

Figure 22. AGAINST

The continuum suggests that free or dependent grammatical elements are formed from lexical components. The lexical component and gestures are encompassed at the initial stage of the continuum process, having their own meaning and functioning independently. At the very last stage of it, simultaneous bound morphemes are included. They depend entirely on the base to which they are attached and cannot function independently. Within these stages, there is a transitional phase, where sequential signs are beginning to grammaticalize. Consequently, morphemes sequentially attached to a base show productivity and create complex structures. However, they have not yet become simultaneous bound morphemes and are homophones with the corresponding free morpheme. The opposition morpheme in LSC is enfolded in this continuum. It may be attached to several bases both simultaneously and sequentially, as outlined in Table 2.

Table 2. Opposition morpheme undergoing grammaticalization

LSC sign	Type of morpheme	Addition to the base	Continuum stage
AGAINST	free morpheme	N/A	initial stage (–)
LAWYER + AGAINST 'prosecutor'	bound morpheme (homophone to the free morpheme)	sequentially	transitional stage (±)
CRIME	bound morpheme (D-handshape affix)	simultaneously	last stage (+)

When it is attached simultaneously to a base, as in CRIME, the affix is fully grammaticalized (+) and is directly applied to the base with the D-handshape. When it is attached sequentially, the derivational process involves a string of two signs attached one after the other, such as in LAWYER + AGAINST 'prosecutor'. In this case, the affix is homophonic with the corresponding free morpheme and falls into the transitional stage (±). Although it cannot be distinguished in the phonological interface from the free morpheme, its structure and morphological behavior allow for it. AGAINST functions as an opposition bound morpheme, activating a pattern and providing a constant meaning.

5. Discussion

The connection between LSC and spoken language morphological and phonological interfaces delves into the fundamental bases of grammar. While the two languages are expressed through different modalities, they share the underlying principles of morphology, that is, the compositional structure and the main ingredients for word formation.

The general tradition of separating studies on sign languages and spoken languages originated from the recent and belated research on sign languages as natural languages in the 1960s (Stokoe 1960), combined with the current and widespread misunderstandings of sign languages as artificial languages or as dependent on the surrounding spoken language. However, like other sign languages, LSC exhibits

complex morphological systems that allow speakers to convey meaning through the combination of morphemes (smaller meaningful units). These units can be free morphemes, which can work independently in a sentence, as in EQUAL (LSC), or bound morphemes, which are attached to free morphemes to convey meaning, as in EQUALITY (LSC), where the arch path movement is attached to the base EQUAL.

The analysis of morphological complex signs in LSC sheds light on the relationship between linguistic theory and morphology across modalities. This paper confirms that sign languages can be analyzed from a morphological perspective because language modality does not affect the theoretical level; it rather only affects the articulatory level. Abstract linguistic features can be studied in the same way in sign language and spoken language, such as the expression of iterative actions, qualitative attributes, and other abstract features through the addition of bound morphemes to a base. This implies that there are identifiable patterns that are distinguished through modalities with the means of their articulation, but theoretically they work in the same way. For example, the D-handshape in LSC is analyzed as an opposition morpheme, that may be attached simultaneously to the base LAW to constitute the derivative CRIME. In this case, the opposition morpheme is added by changing the original B-handshape of the base into the D-handshape. Opposition or negation morphemes also exist in other sign languages and spoken languages, such as in Catalan, with the prefixes *des-* and *in-* may be attached to an adjectival base – like *lleial* 'loyal' or *solidari* 'supportive' – to create adjectival derivatives – such as *deslleial* 'disloyal' and *insolidari* 'unsupportive'. In those cases, the bound morphemes are added sequentially, immediately preceding the base, whereas in LSC, the affix is attached simultaneously to the base in a non-concatenative way. This shows that the feature of opposition can be conveyed in a complex structure with bound morphemes both in sign language and spoken language, although they are conveyed with different articulators.

Like handshape, movement in LSC also transforms simple morphemes into complex ones. For instance, TREE is a simple free morpheme, while FOREST incorporates the movement affix as a derived sign. This construction is also studied within reduplication, as the base is repeated in signing space. Spoken Romance languages achieve this word-formation through suffixation, like in Catalan, with *roure* 'oak' / *roureda* 'oak forest' or *paper* 'paper' / *paperam* 'pile of papers', behaving as bases and derivatives, respectively. However, more geographically distant languages, like Austronesian languages, employ reduplication for recategorization. For instance, the reduplication of the Samoan verb *'apa* 'beat of wings' forms the noun *'apa'apa* 'wing' (Mosel and Hovdhaugen, 1992: 223) and the Hiligaynon noun *túig* 'year' constitutes the adverb *túig-túig* 'anually'. This morphological process is structurally and grammatically very similar to LSC, both in flexion and derivative frameworks, where repeating a base creates derivatives or expresses plurals. Sign language research has focused on the process of reduplication, such as previous studies in LSC (Ribera-Llonc et al. 2019), in Sign Language of the Netherlands (Schreurs 2006) or in American Sign Language (Klima et al. 1979). The previous examples show that certain phenomena of spoken language morphology are more similar to LSC than the surrounding spoken languages, like Catalan or Spanish.

Movement also plays a role in the categorization of signs, as it is a morpheme that allows recategorizing another morpheme. It works like verbalization processes in spoken language, where suffixes may alter word forms and grammatical categories when added to nominal or adjectival bases. For instance, in Catalan, verbs like *parpellejar* 'blink' or *suavitzar* 'soften' have been formed from the noun *parpella* 'eyelid' and the adjective *suau* 'soft', respectively. In LSC, this process is found in two different ways: on the one hand, by the addition of a path movement to a base, as in the noun BROOM (with simple movement) and the verb TO-BROOM (with path movement) (Ribera Llonc 2015; Ribera-Llonc et al. 2019), and on the other hand, by altering the disposition of the sign, as shown in FACTORY and TO-PRODUCE. While FACTORY has a circular forward movement, TO-PRODUCE moves from [ipsi] to [central] sides of signing space.

This paper discusses simultaneous affixation through handshape and movement parameters in derivation. However, affixes in sign languages may also be attached to a base sequentially, that is, right before or after it. Previous studies argued that sequential affixes arise from the grammaticalization of free lexical signs (Meir 2003; Aronoff et al. 2005; Pfau & Steinbach 2005; Janzen 2012), such as the grammaticalization of the sign PERSON, which can be attached to a base with an agentive function. For example, in ASL, TO-TEACH+PERSON$_{ag}$ 'teacher' (Aronoff et al. 2005) and, in LSC, PERSON$_{ag}$+TO-CALCULATE 'accountant' (Villaécija 2023) are sequential derivatives that come from the grammaticalization of PERSON. The negation affix has also been analyzed sequentially in ASL, as in SHAME+NOT-EXIST$_{af}$ 'shameless' or SUCCESS+NOT-EXIST$_{af}$ 'unsuccessful' (Meir 2012). The way of addition to the base of the negation affix is different from the analysis in this paper in LSC with the Ⅾ-handshape. The ASL negation affix is more similar to the spoken language structure. In this case, it is attached to a base sequentially, with the grammaticalized sign NOT-EXIST$_{af}$.

In LSC derivation exhibits productivity through the simultaneous addition of movement and handshape affixes in the phonological-morphological interface. The present research provides valuable insights into theoretical morphological issues in general, as there are parallels with findings from previous literature both on sign language and spoken language morphology.

6. Conclusions

This paper delves into the process of simultaneous derivation in LSC, focusing specifically on the addition of affixes in a non-concatenative manner to several bases. The analyses are based on the integrated morphological model (Villaécija 2023), and examine two key parameters as simultaneous affixes: handshape and movement.

Concerning the movement affixes, the analysis highlights their high productivity in LSC, particularly in the creation of derivatives. Two main types of movement affixes are identified: path and circular movements. Path movements encompass distal or proximal, linear, and arch movements, each contributing to the formation of signs with distinct meanings. Distal or proximal movement affixes convey time

expression signs, such as TOMORROW / THE-DAY-AFTER-TOMORROW and linear and arch path movement affixes involve generic and abstract signs, respectively, as in TREE / FOREST and EQUAL / EQUALITY. Circular movement, on the other hand, introduces repetition or changes in sign disposition. This affix, when attached to certain bases, allows the creation of abstract derivatives (like BROTHER / SOLIDARITY), reiterative derivatives (as in TO-HIT / TO-ABUSE) and verbalized signs (such as FACTORY / TO-PRODUCE).

The Ⅾ-handshape, plays a significant role in derivation on LSC, adding the constant meaning of opposition to nominal bases. The paper demonstrates how handshape affixes modify the handshape parameter of bases, leading to the creation of new lexemes with different morphological structures. Considering the continuum of grammaticalization, the opposition morpheme in LSC may also be attached to a base sequentially.

Despite differing in modality, LSC and spoken languages share underlying morphological principles, notably affixation, which involves adding bound morphemes to a base to alter their meaning or grammatical behavior, as observed in Catalan with prefixes like *des-* (in *deslleial* 'disloyal') or suffixes like *-eda* (in *roureda* 'oak forest'). However, in LSC, derivation showcases productivity through simultaneous movement and handshape affixation, challenging traditional notions of affix application. For instance, the opposition morpheme in LSC is added by the Ⅾ-handshape bound morpheme in the base LAW to constitute CRIME. In this sense, differences in modality reveal unique aspects of the articulation of morphological processes, such as handshape distinctions in LSC. While the morphological inner structure works in the same way across modalities, the way of articulation influences affix realization and its meaning conveyance.

Derivatives in LSC show a different structure compared to inflection, which allows the two morphological processes to be distinguished. That is the case of path movement, which can be added to a free morpheme to express plural (inflection) or to constitute a new lexeme (word-formation). The sign EQUAL with the arch movement attached to it illustrates this distinction. The derivative is clearly denoting a new lexeme created from the base EQUAL, which implies that a new gloss must be expressed, namely EQUALITY. On the other hand, the bound morpheme in EQUAL-arch does not add new meaning to the base but provides grammatical information. In the phonological interface, both signs share the same characteristics, while morphologically and semantically they differ.

As in other sign and spoken languages, there are bound morphemes that productively create signs in LSC. The features that the morphemes convey are opposition, reiteration or verbalization, among others. Future directions may involve several linguistic approaches related to it. For instance, how other linguistic features are conveyed in morphological complex structures of LSC, such as causative, adverbial, intensifying or reversive morphemes, to name just a few. Also, as other sign languages, LSC shows a high level of grammaticalization for constituting bound morphemes. The evolution of a free morpheme into a bound morpheme and its interaction within the phonological-morphological interface would illustrate how lexicon and grammar function. Finally, a cross-linguistic perspective should be

followed to examine how the two modalities convey the same meaning in complex structures. All in all, in sign languages there are also language families that are not related to their spoken language counterparts. The study of sign languages families using morphology shed light not only on the evolution of the lexicon but also on sign language grammars.

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