Morphology in Sign Languages

Theoretical Issues and Typological Contrasts

Roland Pfau
University of Amsterdam, The Netherlands

Markus Steinbach
University of Göttingen, Germany

1 General properties of sign language morphology and the phonology–morphology interface

In their influential study on sign language morphology, Aronoff et al. (2005) discuss selected inflectional and derivational phenomena from American Sign

The Wiley Blackwell Companion to Morphology.
Edited by Peter Ackema, Sabrina Bendjaballah, Eulàlia Bonet, and Antonio Fábregas.

DOI: 10.1002/9781119693604.morphcom048

Language (ASL) and Israeli Sign Language (ISL) and come to the conclusion that sign language morphology presents us with a unique morphological ‘paradox’ not found in spoken languages. They argue that this paradox results from the fact that on the one hand most sign languages are relatively young languages that share certain properties with creole languages, but on the other hand they still display highly complex strategies for word formation, especially in the domain of inflection. Signs can be of considerable morphological complexity; what is more, inflectional processes often apply in a simultaneous fashion, that is, by changing the phonological building blocks of the stem to which they apply rather than through sequential affixation. According to Aronoff et al., both the complexity of signs and the simultaneous nature of processes would be unexpected in creole languages, and this is what creates the paradox.

Let us illustrate this important point with two examples – one inflectional, one derivational – from Sign Language of the Netherlands (NGT). Figure 1a presents the base form of the sign GIVE; this sign is specified for a location (neutral space in front of the upper part of the signer’s body), a straight outward movement starting in front of the signer’s body toward a neutral location in the middle of the horizontal plane of the signing space, and a specific handshape (a flat hand). These three components are taken to be the manual building blocks of signs (sometimes the orientation of the hand is considered a fourth component) and have been argued to function analogously with phonological segments in spoken languages (Sandler 1989; Brentari 1998, 2012). In addition to manual segments, some signs are lexically specified for non-manual features such as mouth movements or facial expressions (Pendzich 2020). Now consider the sign in Figure 1b, which is a morphologically modified variant of GIVE. As is evident from the image, all components of the sign are modified: the movement is now inwards, going from a locus closer to the addressee towards the signer; the handshape is different and a non-manual marker, namely puffed cheeks, is co-articulated with the sign. Each of these modifications adds meaning and is thus of a morphological nature: (i) the beginning point of the movement is a subject agreement marker (second person), the end point is an object agreement marker (first person), and the change in the direction of movement is

(a) (b)

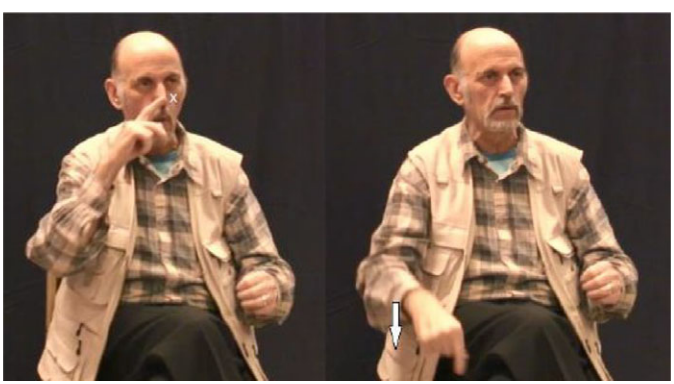
Figure 1 Simultaneous morphological modification of the NGT sign GIVE: (a) base form of the verb; (b) inflected or modified form, with the meaning ‘you give me a flat object with some effort’. In both cases, begin and end point of movement are shown.

actually a by-product of these two markers, as movement usually proceeds from the referential locus (R-locus) assigned to the subject to the object's R-locus; (ii) the handshape is a so-called handling classifier morpheme, which reflects certain shape characteristics of the handled entity; (iii) finally, the non-manual marker indicates that the action is executed with some effort. Hence the meaning of this complex sign can be paraphrased as 'you give me a flat object with some effort'. Crucially, however, when we look at the signs as a whole, we see that their sequential structure is the same: they both involve a Location_1–Movement–Location_2 (LML) sequence.[1] Clearly, all morphological modifications are realized simultaneously (stem-internally) rather than sequentially – or, to put it another way, '[s]imultaneous morphology consists of the superimposition of morphological structure on the canonical LML unit' (Aronoff et al. 2005, 310).

Studies carried out on a considerable number of sign languages suggest that inflectional processes, almost without exception, either are of the simultaneous type or involve reduplication (unless they can be analyzed as involving clitics; see, for instance, Makharoblidze 2015 for case markers in Georgian Sign Language and Nevins 2011 for agreement markers in ASL).

In contrast to the example in Figure 1b, the morphologically complex sign in Figure 2, an instance of derivation, involves a sequentially realized affix, a negative prefix, which we gloss as UN-. In combination with the sign DEEP, the prefix yields the meaning 'shallow' (lit. 'undeep'; Klomp 2021). Derivational processes of the type illustrated in Figure 2 appear to be scarce across sign languages (see Aronoff et al. 2005 for the discussion of some ASL and ISL examples and Tomaszewski 2015 for negative prefixes in Polish Sign Language).

By presenting these examples, we do not mean to imply that derivational processes as a group differ from inflectional ones in their phonological realization. On the contrary, most of the attested derivational processes are in fact also realized by changing the internal composition of a sign instead of attaching an affix before or after it – the non-manual marker in Figure 1a is a case in point, illustrating simultaneous derivation. This marker is usually analyzed as a non-manual adverbial (Liddell 1980). For Italian Sign Language, Fornasiero (2020) offers a



UN– DEEP

Figure 2 Negative prefix in NGT. Source: Klomp (2021, 186).

comprehensive overview of non-manually realized evaluative morphology (e.g. diminutive, intensive, pejorative). In addition, movement changes (sometimes in combination with non-manual markers or reduplication, or both) may mark certain derivational processes, such as the attenuative (Padden and Perlmutter 1987) and noun–verb pairs (e.g. Supalla and Newport 1978 for ASL; Kimmelman 2009 for Russian Sign Language).

The two examples allow us to summarize an important generalization made by Aronoff et al. (2005, 335), who argue that the two types of sign language morphology display different clusters of properties. On the one hand, simultaneous processes are very similar across sign languages,[2] are related to spatial cognition, are motivated, and are not related to freely occurring signs. All of this is true of the sign in Figure 1b. The movement and the handshape change are – at least to some extent – iconic (although the loci that mark the subject and the object may be arbitrary, in particular in the case of non-present third-person referents). Both the handshape and the movement iconically represent the transfer and the size and shape of an entity (we discuss agreement and classifiers in more detail in Sections 2 and 3 respectively).

Sequential processes, on the other hand, tend to be specific to individual sign languages, are not related to spatial cognition, are arbitrary, and are often the result of a grammaticalization process from free signs to bound morphemes (for grammaticalization, see Pfau and Steinbach 2011). These properties hold for the sign in Figure 2: the prefix is unique to NGT, is arbitrary, and can be argued to have grammaticalized from the sign NOSE. Klomp (2021, 186) argues that '[t]he form of the morpheme originates from speech therapy classes, in which the Dutch negative prefix *on-* was visualized by an index finger on the nose, because of the nasal sound' – that is, it can be considered a loan element from Dutch. She also observes that its use among native signers is subject to considerable variation (another characteristic of sequential morphology listed by Aronoff et al. 2005).

Having offered a broad sketch of general properties of sign language morphology and of the interaction between phonology and morphology, we shall now turn to a discussion of selected morphological processes. We emphasize that it is not our goal to provide a comprehensive survey of attested morphological phenomena. We will, for instance, neither be concerned with derivation and compounding[3] nor discuss all inflectional phenomena attested in sign languages (see Meir 2012 and Pfau 2016a for overviews). Rather we selected three inflectional processes that will allow us to evaluate modality-specific and modality-independent properties of sign language morphology,[4] not just in the way in which they are phonologically realized, but also with respect to how they are accounted for within different theoretical models. Note that we are also selective about the analyses we present: we focus on generative accounts in the broad sense and discuss only accounts with a strong morphological component. The ultimate goal is thus to investigate how far certain morphological phenomena in sign languages can contribute to our understanding of morphological typology and theory (see also Sandler 2021).

Moreover, this entry does not aim at presenting comprehensive overviews of competing analyses of one and the same phenomenon. Instead, it discusses one type of analysis for each phenomenon. The advantage of this approach is that it allows for each theory to be presented in greater detail. In addition, the entry covers the variety of theories on the market by focusing on a different theory in each section. Section 2 starts by addressing the spatial modification of verbs. The grammatical status of this phenomenon is subject to debate in the sign linguistics literature, but we take the side of approaches that treat it in terms of syntactic agreement and we sketch a formal generative account that employs modality-independent formal mechanisms developed within the Minimalist Program. Section 3 then turns to classifiers, which have been analyzed as a type of stem-internal change, and we present analyses couched in the framework of Distributed Morphology (DM). Morphological reduplication, in particular the pluralization of nouns, is the topic of Section 4. The discussion highlights a striking feature of pluralization in NGT, namely the attested variation, and we show how it has been accounted for within stochastic Optimality Theory (OT). All three sections address first of all the morphophonological realization of the phenomenon under study, also evaluating potential modality-specific properties, and only afterwards proceed to the formal account. The final section turns to two issues of a more general nature: it addresses the morphological ‘paradox’ observed in sign languages from a general typological perspective; and it discusses the impact of gesture on sign language morphology.

2 The spatial modulation of verbs: agreement

Recall from the example in Figure 1 that agreement in NGT is realized by a modification of the phonological feature path movement (sometimes in combination with hand orientation): while the beginning of the path movement is controlled by the R-locus assigned to the subject, the end point of the movement (and the hand orientation) is controlled by the corresponding R-locus of the object. This subject–object agreement pattern is found in many unrelated sign languages: in other words, verbs in sign languages have the ability to express agreement with two of their arguments.

Similar agreement patterns are attested in many unrelated spoken languages: according to Siewierska (2005), 193 out of 378 languages exhibit person marking of both the A(gentive) and the P(atient) arguments. In the Tawala example in (1), for instance, agreement with the A-argument is marked by the prefix *i*, while the suffix *hi* expresses agreement with the P-argument.

(1) *kedewa* *kamkam* *i-uni-hi*
dog chicken 3SG.A-kill-3PL.P
‘A dog killed the chickens.’
(Tawala; Ezard 1997 in Siewierska 2005, 414)

It is a well-known fact that the constraints on the overt realization of double agreement in spoken and sign languages are quite complex. This holds especially for object marking, which is subject to specific constraints on differential object marking in many languages (Comrie 1989; Bossong 1991; Aissen 2003; for a cross-linguistic analysis of argument marking in ditransitive constructions, see

Haspelmath 2005). This section focuses on basic properties of agreement marking in sign languages and ignores more specific aspects such as locus agreement with plain verbs, the animacy restriction on agreement controllers, the degree of optionality of agreement marking, and the gestural basis of agreement.[5] It starts by discussing the morphophonological realization of subject and object agreement in sign languages, including some modality-specific properties of agreement. Then it turns to a morphosyntactic analysis of sign language agreement within the minimalist program.

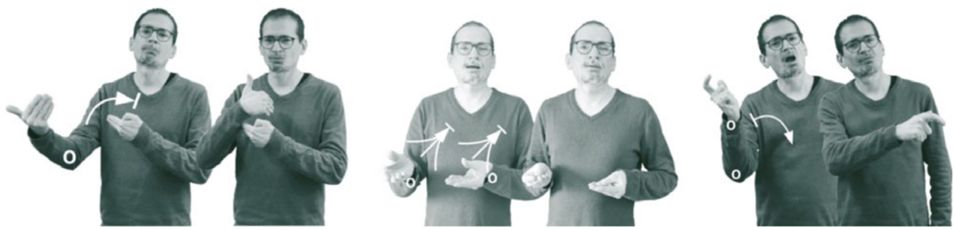
2.1 The morphophonological realization of agreement

At first sight, sign languages belong to the class of languages that express double agreement, i.e., agreement between the verb and two of its arguments. In the example illustrated in Figure 1b, the two arguments controlling agreement are the subject (or agent) and the indirect object (or recipient), see also the German Sign Language (DGS) example (2a).[6] However, the agreement picture is much more complex in sign languages. In addition to the simultaneous realization already discussed in Section 1, agreement in sign languages exhibits further modality-specific properties (Lillo-Martin and Meier 2011; Mathur and Rathmann 2012). This subsection discusses three properties that generative analyses of agreement have to account for.

First, in all sign languages investigated so far, only a comparatively small class of verbs permit the overt expression of agreement through the modification of path movement and hand orientation (Padden 1988). These verbs are called 'agreement verbs'. The majority of verbs cannot be inflected either for subject or for object agreement. This large class of so-called plain verbs is characterized by the fact that the phonological features relevant to the overt realization of agreement are lexically specified, which renders adapting these features to the R-loci of the subject and object impossible. Plain verbs are typically used in their uninflected base form, as illustrated in (2b).[7]

(2) a. YESTERDAY POSS_1 MOTHER INDEX_{3a} $_{3a}\text{VISIT}_1$
'Yesterday my mother visited me.'
b. INDEX_{3a} NEW TEACHER LIKE
'S/he likes the new teacher.'
c. POSS_1 BIRTHDAY PARTY, POSS_1 MOTHER INDEX_{3a} $_{3a}\text{INVITE}_1$
'As for my birthday party, I will invite my mother.'
d. INDEX_{3a} NEW TEACHER LIKE $_{3a}\text{PAM}_{3b}$
'S/he likes the new teacher.'
(DGS; Pfau et al. 2018, 4–5)

Second, within the class of agreement verbs, two different overt realizations of agreement must be distinguished: with regular agreement verbs such as VISIT in (2a), the path movement starts at the R-locus associated with the subject and ends at the R-locus associated with the object; this is illustrated in Figure 3a. By contrast, with so-called backwards agreement verbs such as INVITE in (2c), the hands move in the reverse direction: the path movement starts at the R-locus



(a) $_{3a}$VISIT$_1$ ('S/he visits me') (b) $_{3a}$INVITE$_1$ ('I invite her/him') (c) $_{3a}$PAM$_{3b}$

Figure 3 Ways of realizing agreement in DGS: (a) regular agreement verb VISIT; (b) backward agreement verb INVITE; (c) agreement auxiliary PAM. Source: Finkbeiner and Pendzich (2021).

associated with the object and ends at the R-locus associated with the subject, as is illustrated in Figure 3b (the hands close during the movement).

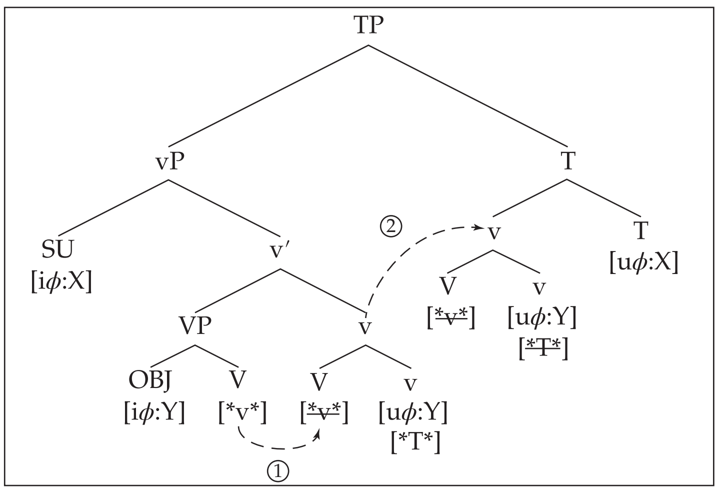
A third modality-specific property attested in many (but not all) sign languages is the use of a dedicated agreement auxiliary (Sapountzaki 2012; for the grammaticalization of agreement auxiliaries, see Steinbach and Pfau 2007 and Section 5.2 here). These auxiliaries are typically used with plain verbs to bridge the agreement gap caused by the lexical specification of the path movement that prohibits their inflection. The DGS agreement auxiliary PAM (person agreement marker), which has developed from the noun PERSON, is illustrated in Figure 3c. In the DGS example (2d), PAM is used in sentence-final position, where it overtly realizes agreement with the subject and object in the same way regular agreement verbs do, namely by moving from the R-locus of the subject ('3a') to the R-locus of the object ('3b').[8]

2.2 Theoretical account: minimalism

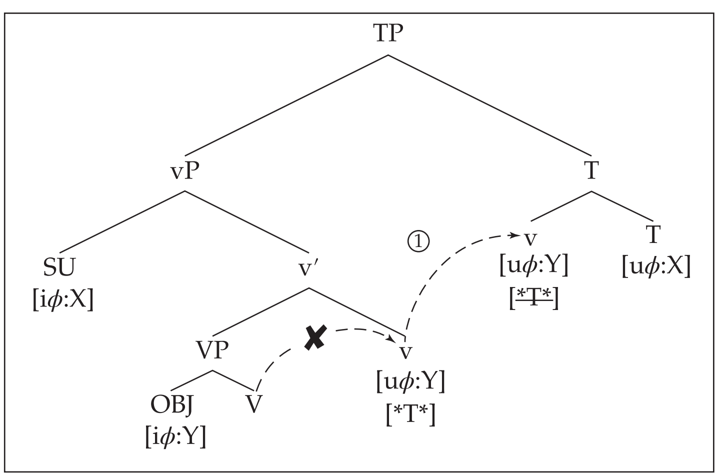
Different kinds of analyses have been proposed to account for the specific properties of verb–argument agreement in sign languages. While some analyses highlight the gestural basis of agreement (e.g. Schembri et al. 2018), others propose a hybrid analysis that integrates semantic and grammatical aspects (e.g. Meir 2002). Generative analyses come in two variants: agreement marking on the verb has been analyzed either as cliticization of phonologically reduced pronouns (e.g. Nevins 2011) or as the result of morphosyntactic feature checking (e.g. Pfau et al. 2018).[9]

In this section we take verb agreement in sign languages to be an instance of simultaneous inflection. We focus on the last kind of analyses and show how sign language agreement can be analyzed on the basis of modality-independent morphosyntactic principles within the minimalist program (Chomsky 2000). On the one hand, the spatial modification of the verb found in agreement inflection is clearly modality-specific. Sign languages systematically use the expressive power of the three-dimensional signing space to realize different grammatical features. On the other hand, there are efforts to capture this modality-specific realization of grammatical features with a modality-independent machinery, that is, while the basic grammatical structures and principles are modality-independent, the overt morphophonological realization is clearly modality-dependent. Recall from the discussion of the NGT example in Figure 1 that agreement morphemes are not attached to the verb stem but inserted in the lexically unspecified L-slots of the stem, as can be seen in Figure 3. Following Aronoff et al. (2005), agreement morphology consists of the superimposition of morphological structure on the canonical LML structure of the verb. With regular agreement verbs such as $_{3a}$VISIT$_1$, the first L-slot (spatially) agrees with the corresponding R-locus of the subject and the second L-slot with the R-locus of the object, yielding the inflected form L_{3a}-M-L_1.

Since agreement verbs in sign languages typically agree with the subject and the object, the morphosyntactic derivation of agreement proceeds in two steps. This is illustrated in the structure in Figure 4a. The agreement verb first moves from its base position in V to v because agreement verbs are lexically specified for the feature [*v*] triggering movement to v. Then the V+v complex moves further up



(a)



(b)

Figure 4 Morphosyntactic derivation of (a) regular agreement verbs and (b) plain verbs. Source: Pfau et al. (2018, 21).

to T. This second movement is triggered by the feature [*T*] specifying v. The movement of V to v and T is the basis for a copy of the phi-features of the object and subject onto v and T respectively. The corresponding locus features are then realized on the agreement verb by a phonological specification of the L-slots (i.e. the beginning and end points of the path movement) of the verb.

Unlike regular agreement verbs, plain verbs are not specified for [*v*] – probably because the corresponding L-slot is already lexically specified – and are thus not available for the overt realization of an agreement relation. Hence plain verbs do not move to v. However, v again moves to T to check the feature [*T*]. This is illustrated in the structure in Figure 4b. Depending on whether an agreement auxiliary is inserted into v or not, the v-to-T movement is either realized as zero or expressed on the agreement auxiliary. Both options are illustrated by the examples (2b) and (2d). In (2b), v does not host a lexical element. Therefore agreement cannot be overtly realized. By contrast, in (2d) the L-slots of the agreement auxiliary PAM, which is inserted in v, can be used to overtly realize subject and object agreement.

Backwards agreement verbs such as $_{3a}$INVITE$_1$ in example (2c) show the reverse alignment pattern, which can be compared to ergative patterns in spoken languages. This reverse pattern is triggered by a reverse ordering of the agree and merge operations on v, as illustrated in Figure 5. With regular agreement verbs, v agrees with the object first and then merges with the subject, which then agrees with T, as illustrated in Figure 4a. By contrast, with backwards agreement verbs, v first merges with the external argument. As a consequence, the subject is available for agreement with v. In this reverse pattern, v thus agrees with the subject that occupies the specifier of vP, and T, which cannot agree with the subject anymore, agrees with the object in Spec, VP, which is still available for an agreement relation. Consequently, the first L-slot of the verb is specified by the R-locus of the subject and the second one by the R-locus of the object; and this yields the reverse movement pattern. One reason for the existence of backwards agreement verbs in sign languages might be the gestural origins of agreement patterns, which are still visible even in more grammaticalized agreement systems such as the one described for DGS in this section. We come back to this issue in Section 5.2.

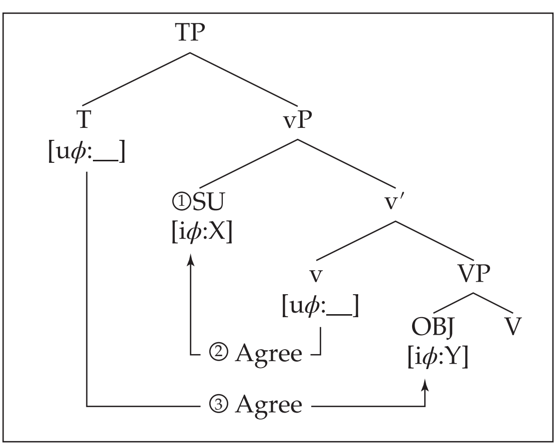


Figure 5 Morphosyntactic derivation of backwards agreement verbs. Source: Pfau et al. (2018, 25).

3 Predicate classifiers

Predicate classifiers are affixes that attach to verb stems and reflect certain semantic (e.g. human or vehicle) or shape (e.g. cylindrical or flat) characteristics of one of the verb's arguments (Allan 1977; Aikhenvald 2000). The examples from Caddo in (3) illustrate the phenomenon. The two clauses constitute a minimal pair that differs only in the classifier prefix – in other words only the classifier distinguishes between liquid coffee and ground coffee.

(3) a. *Kapí:* ***kan**-čâ:ni'ah*
coffee CL:liquid-buy.PST
'He bought (liquid) coffee.'
b. *Kapi:* ***dân:**-čâ:ni'ah*
coffee CL:powder-buy.PST
'He bought (ground) coffee.'
(Caddo; adapted from Mithun 1986, 386)

In what follows, we start again by addressing the morphophonological realization of predicate classifiers in the visual–spatial modality. The presentation includes an evaluation of potential modality-specific properties of classifiers in sign languages. Then we discuss formal accounts of predicate classifiers, with a focus on analyses couched within the framework of DM.

3.1 The morphophonological realization of classifiers

Some scholars argue that handshape morphemes that combine with certain verbs of movement and location fulfil a function similar to that of classifiers in spoken languages of the type illustrated in (3) (Supalla 1986; Zwitserlood 2012), and for this reason refer to them as 'classifier handshapes'. Such morphemic handshapes have been observed in most sign languages studied to date, but their shape and contexts of use may be subject to variation. Here we address only two types of classifiers that are commonly distinguished in the literature: handling classifiers and entity classifiers.[10] Use of the former type has already been illustrated in Figure 1b, where the handshape signals that a three-dimensional flat entity is handled – that is, indirectly reflects shape properties of the direct object. Other examples of handling classifiers are shown in Figure 6a. By contrast, entity classifiers reflect the shape of a stationary or moving entity directly: the handshape represents the entity as a

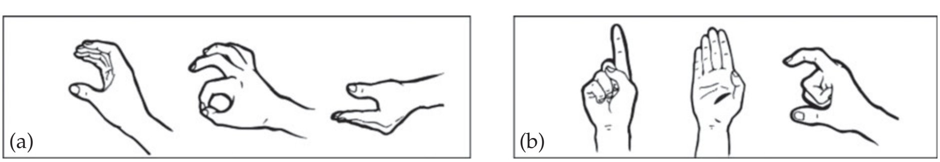


Figure 6 Examples of (a) Handling classifiers, which classify the direct object of transitive verbs (e.g. GIVE), and (b) Entity classifiers, which classify unaccusative subjects of intransitive verbs (e.g. MOVE, BE.LOCATED).

whole, and this entity is generally a non-agentive subject. Use of entity classifiers is illustrated by the DGS examples in (4). In (4a) the leftmost handshape in Figure 6b, referring to an upright human being, is used, while in (4b) the middle handshape in Figure 6b (palm oriented downwards) combines with the movement root (which we gloss as MOVE).

(4) a. STREET CHILD $_{\text{right}}$MOVE$_{\text{left}}$-CL:human
'A child crosses the street (from right to left)'.
b. STREET CAR $_{\text{right}}$MOVE$_{\text{left}}$-CL:car
'A car crosses the street (from right to left)'.
(DGS)

Assuming that the handshape fulfils a morphological function in these cases, it is clear that we are not dealing with an instance of sequential affixation but rather with a stem-internal change. As for the modification, two scenarios are possible: (i) the movement roots that allow for the combination with classifier handshapes (e.g. GIVE, MOVE, BE.LOCATED) are underlyingly not specified for the handshape feature and the classifier fills the handshape slot; (ii) the predicates are lexically specified for the handshape feature and classification triggers a change in handshape. In principle, it is also possible that the two classifier types we are concerned with here behave differently in this respect.

Of course, morphological processes are also commonly realized by stem-internal changes in spoken languages – think, for instance, of ablaut–umlaut phenomena (see Section 5.1 for further discussion). However, we are not aware of a spoken language in which classification would be realized by means of stem-internal changes. In other words the morphological process under discussion is not modality-specific, but its use in classification may be.

In conclusion to this section, let us point out that it has been suggested (for ISL) that classification is an instance of noun incorporation (Meir 2001). While it is known that predicate classifiers may be grammaticalized from incorporated nouns (Mithun 1984, 1986), we think that a noun incorporation analysis is not on the right track, at least not for DGS and NGT (Glück and Pfau 1998; Zwitserlood 2003). Crucially, in these sign languages, the entity that the classifier refers to has to be mentioned in the context (see (4)), and the phonological shape of the classifier does not necessarily correspond to that of the noun it refers to (e.g. the sign CHILD in (4a) does not involve the leftmost handshape in Figure 6b, and CAR in (4b) does not involve the middle handshape in Figure 6b). Moreover, the very same noun may trigger a different change of handshape in handling classifiers and in entity classifiers. This clearly shows that the noun does not become part of the verb. Rather the classifier handshapes relate to a class of nominal referents that share certain properties (see Tang et al. 2021 for a critical evaluation of the incorporation account).

3.2 Theoretical account: Distributed Morphology

Different analyses regarding classifier handshapes have been put forward in the literature (e.g. Cogill-Koez 2000; Meir 2001; Liddell 2003; Benedicto and Brentari

2004), and for some sign languages it has been argued that classifiers should be analyzed as an instantiation of agreement, in spite of their iconic properties. The evidence in favour of making this assumption comes from three facts: (i) classifiers systematically encode inherent features of a nominal controller; (ii) the use of a classifier is generally obligatory; and (iii) handshapes are drawn from a limited inventory (Glück and Pfau 1998; Benedicto and Brentari 2004; Zwitserlood and van Gijn 2006; Kimmelman et al. 2020). Our focus will be on analyses of this type, couched in DM, but we will briefly address alternative accounts that highlight the impact of gestural resources in Section 5.2.

Note also that we are concerned only with the morphological side of the phenomenon, neglecting for the most part the interaction of classifiers with syntax, in particular argument structure. Suffice it to say that it has been argued that classifiers interact with argument structure in interesting ways: entity classifiers classify the internal argument of unaccusative predicates (e.g. the moving car in (4b)), while handling classifiers classify the internal argument of transitive predicates (e.g. the handled entity in Figure 1b).[11] According to some accounts, it is actually the classifier that introduces functional projections to host the relevant arguments; this means that the argument structure depends on the classifier, not vice versa (Benedicto and Brentari 2004; Kimmelman et al. 2020).

The earliest generative accounts of sign language classifiers are couched in DM, a theoretical model that assumes that syntax manipulates nothing but acategorial roots and morphosyntactic features, while phonological spell-out only takes place at the level of phonological form (PF), where vocabulary items are inserted into terminal nodes (Halle and Marantz 1993; Siddiqi 2010). Glück and Pfau (1999) offer a DM account of various inflectional processes in DGS (next to classification, they address agreement and aspectual inflection). As for their approach to classification, two DM assumptions are of importance: (i) at the level of morphological structure (MS), which is sandwiched between syntax and PF, agreement nodes are inserted and inherent features of nominal controllers are copied onto the agreement head(s); (ii) at PF, phonological readjustment rules may change the form of vocabulary items in the context of certain features.

With this in mind, let us consider again the example involving a handling classifier in Figure 1b (the fact that this example is from NGT doesn't matter). In this example, the relevant features of the theme argument will be copied onto the direct object agreement node (AgrDO) at MS. Glück and Pfau further assume that the vocabulary item that will be inserted into AgrDO is a zero morpheme, which triggers a phonological readjustment rule, represented in abstract form in (5): a verb that belongs to a certain class (say, Class I) takes on one in a limited set of classifier handshapes when this verb appears in the context of a feature or set of features in AgrDO.

(5) $\text{handshape}_{\text{lex}} \rightarrow \text{handshape}_{\text{CL}}$ / V [$[F_x]$, $[F_y]$, … $]_{\text{AgrDO}}$
(where V is a verb of Class I)

In the case at hand, this is what happens: at PF, the abstract root $\sqrt{\text{GIVE}}$ is spelled out by the vocabulary item in (6a), where 'x' and 'y' indicate that the item involves path movement; the classifier agreement affix is spelled out by a zero morpheme. Subsequently the readjustment rule in (6b) changes the handshape on the basis of the features in AgrDO.

(6) (a) √GIVE ↔ X  Y

(b)  ➔  / GIVE [+flat, +3D]$_{\text{AgrDO}}$

In other words, Glück and Pfau assume that classifier predicates are underlyingly specified for handshape and that classification involves a stem-internal change. They compare this change to umlaut–ablaut phenomena, as observed for instance in certain German plurals (see Section 5.1) and in English past tense forms (e.g. *see* ➔ *saw*): these, too, have been argued to involve zero affixes that trigger stem-internal changes in vocabulary items (cf. Halle and Marantz 1993, 126–128). A similar argument is made for aspectual inflection, where readjustment targets the movement component of the verb, while for spatial agreement (2SG subject and 1SG object in Figure 1b), the authors assume that it involves the sequential affixation of spatial loci (in contrast to what we suggested in Section 2.2).[12] Crucially, this line of reasoning leads Pfau and Glück (2000, 441) to conclude that, 'on the morphosyntactic side, simultaneity in the true sense does not exist in DGS. Rather, what we are dealing with in fact is pseudo-simultaneity', which results from the interplay between zero affixes and phonological readjustment.

A few years later, Zwitserlood (2003) refined this approach for classifier predicates in NGT by incorporating insights from more recent versions of DM (see Harley and Noyer 2003) and by offering an account that is more in line with the ideas of Aronoff et al. (2005) set out in Section 1. Deviating from Glück and Pfau, she makes two crucial assumptions: (i) all verbs that combine with classifiers – in her terminology, 'verbs of location, motion and existence' (VELMs) – are unaccusative, that is, take one obligatory internal argument, and thus share the same root $\sqrt{\text{MOVE}}$; (ii) VELMs are not specified for handshape, in fact the vocabulary item that spells out the root is argued to consist of only a movement.

Zwitserlood illustrates the derivation with examples similar to those in (7). Note that the gloss for the classifier predicate is the same in both examples: both predicates involve a downward movement starting from a high locus introduced for the (optional) source argument SHELF.

(7) a. SHELF$_X$ BOOK $_X$MOVE.DOWN-CL:flat
'A book falls down from the shelf.'
b. SHELF$_X$ MAN BOOK $_X$MOVE.DOWN-CL:flat
'A man takes a book down from the shelf.'
(NGT)

In fact, the first steps in the derivation are exactly the same in both cases. First, two internal arguments (of which only the theme argument is obligatory) are merged with the movement root $\sqrt{\text{MOVE.DOWN}}$, and subsequently little v is merged (see Figure 7). For the example in (7a), this is the end of the story. The root will be spelled out by a (downward) movement, agreement with the theme argument

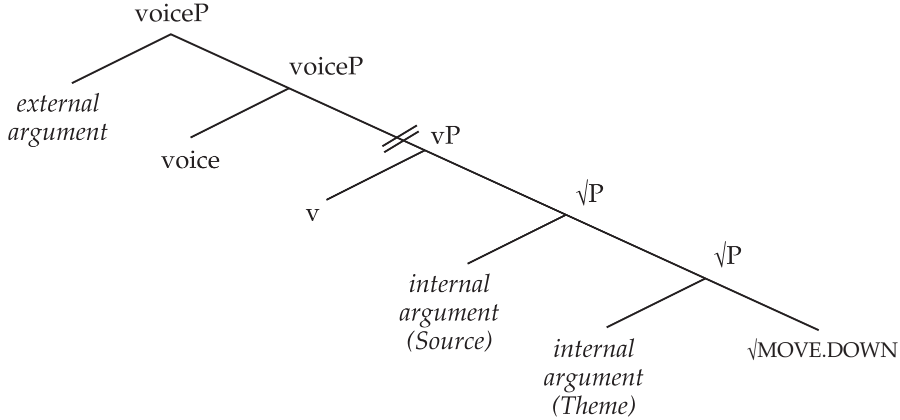


Figure 7 Structure for the derivation of (7a) (= up to the point marked by the cut ||), and of (7b) (= the entire structure). Based on Zwitserlood (2003, 211).

by an entity classifier, and agreement with the source argument by a spatial locus. But for (7b) the derivation continues. First a voice node is merged, and this in turn triggers the merger of a node that hosts an external argument. At the point of vocabulary insertion, the root and source agreement will be spelled out by the same vocabulary items (a movement and a location, respectively), but a different classifier morpheme will combine with the root, namely a handling classifier.

Focusing just on the classifier morphemes, Zwitserlood assumes that two minimally distinct vocabulary items are in competition with each other. In our presentation in (8), the handshape morphemes spell out the same features (inherent features of the controller BOOK).[13] However, the handshape in (8b) will be inserted only in the context of a [+voice] feature. In principle, the vocabulary item in (8a) could be inserted in the same context, as it does not clash with the features in the terminal node; however, it is less specified and will therefore lose the competition to the more specified item in (8b).

(8) (a)  ↔ [+flat, +3D]
(b)  ↔ [+flat, +3D] / [+voice]

When we compare (6) to (8), the difference is obvious: Glück and Pfau assume that the vocabulary items that spell out roots corresponding to classifier predicates are fully specified, as in (6a), and that the appropriate classifier handshape results from a stem-internal change, as in (6b). By contrast, Zwitserlood argues that VELMs are underspecified for handshape and that the classifier is an agreement marker that fills the empty handshape slot (8). In fact the vocabulary item that spells out √MOVE is unpronounceable, as a sign cannot be articulated without a handshape. In the absence of a nominal controller (e.g. the citation form in Figure 1a, or unspecified events that involve the action of giving), Zwitserlood (2003) assumes the insertion of one of two available default handshapes, one of which is the left handshape in (6b).

4 Reduplication: nominal plurals

The focus of this section will be on the pluralization of nouns, but we start with a more general survey of attested reduplication types in order to address how far this typologically widespread morphological strategy is subject to modality-specific properties in sign languages. What is interesting about reduplication is that it may be used iconically in both modalities, in that the repetition of (part of) a stem commonly expresses plurality of entities (e.g. nominal plurals) or plurality of events (e.g. iterative or habitual aspect) (Dingemanse et al. 2015). As before, we start by addressing the morphophonological realization of reduplication in sign languages and potential modality-specific differences. Then we sketch a formal analysis of plural reduplication in the framework of stochastic OT.

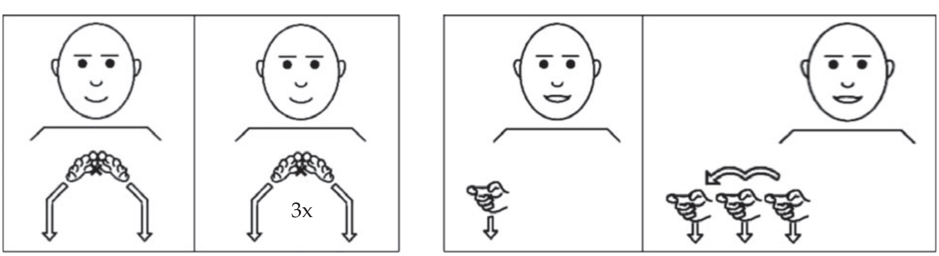
For a general discussion of modality-specific properties of reduplication in sign languages, the reader is referred to Pfau and Steinbach (2006). An overview of number marking and pluralization in sign languages can be found in Steinbach (2012) and in Pfau and Steinbach (2021). Further studies on reduplication and plural marking in sign languages are Fischer (1973), Abner (2017), and Wilbur (2009) for ASL, Bergman and Dahl (1994) for Swedish Sign Language, Pfau and Steinbach (2005b) for DGS, and Zwitserlood et al. (2012) for Turkish Sign Language.

4.1 The morphophonological realization of reduplication

The simplest type of reduplication involves the identical repetition of (a part of) a stem – the base. In both sign and spoken languages, this type may be used to form the plural of a noun, for instance, as illustrated in Figure 8a for the NGT sign HOUSE and in (9a) for the corresponding Malay word *rumah* ('house'). Crucially, the repetition is iconic in that it designates more than one house, but not a specific number of them (*rumah-rumah* does not necessarily mean 'two houses').

(9) a. *rumah* ➔ *rumah-rumah*
'house' 'houses'

(Malay; Blust 2014, 553)



(a) HOUSE (base and plural form) (b) PERSON (base and plural form)

Figure 8 Pluralization of nouns in NGT: (a) by means of simple reduplication of the base; (b) by means of sideward reduplication of the base. Examples: a. HOUSE (base and plural form); b. PERSON (base and plural form). Source: Based on van Boven (2021).

b. *pelek* ➔ *pelek-selek*
'gift' 'small gift'
(Tuvan; Harrison 2000 in Rubino 2005, 114)

The iconicity of the process is somewhat attenuated in the case of non-faithful reduplication, whereby segmental material of the base is changed. This is what we observe in the NGT example in Figure 8b, where the reduplicants of the sign PERSON are slightly displaced with respect to the base; that is, the location segment of the base changes. This is referred to as 'sideward reduplication' (Pfau and Steinbach 2005a). Again, the displacement is not iconic, that is, it is not necessarily the case that the people referred to are next to each other. Non-faithful reduplication is also observed in the Tuvan example in (9b), where reduplication marks the diminutive: in the reduplicant, the initial consonant [p] is replaced by [s].

Besides the two reduplication types illustrated in Figure 8, sign languages also present us with reduplication types that are clearly modality-specific. First, the articulation in space allows for 'backward reduplication' (Pfau and Steinbach 2003), whereby the hands move from location A to location B and then back to A. Backward reduplication has been observed in reciprocals in DGS (Pfau and Steinbach 2003, 2005a), Indo-Pakistani Sign Language (Zeshan and Panda 2011), and Turkish Sign Language (Kubus and Hohenberger 2013), and is illustrated in Figure 9a for the DGS sign HELP: in order to express the meaning 'we help each other', the hands move from a location in front of the signer's body towards the location of the addressee and then back to the initial location. In principle, backward reduplication could be realized in spoken languages by reversing the order of segments (e.g. the hypothetical *marut* ➔ *marut-tumar*); however, to the best of our knowledge, such cases are not attested.

A second modality-specific type of reduplication results from a unique affordance of the visual–spatial modality: the availability of two identical articulators, the two hands. This affordance is exploited for instance in 'simultaneous reduplication'. For NGT, it has been observed that one-handed nouns are occasionally reduplicated by adding the non-dominant hand (with or without additional sequential

(a) HELP (base and reciprocal form) (b) CHILD (base and plural form)

Figure 9 Modality-specific types of reduplication: (a) backward reduplication, as observed in the reciprocal form of certain DGS verbs, e.g. HELP; (b) simultaneous reduplication realized by the non-dominant hand, e.g. to form the plural of the NGT noun CHILD. Sources: (a): Pfau and Steinbach (2003, 12–13); (b): stills from Corpus NGT.

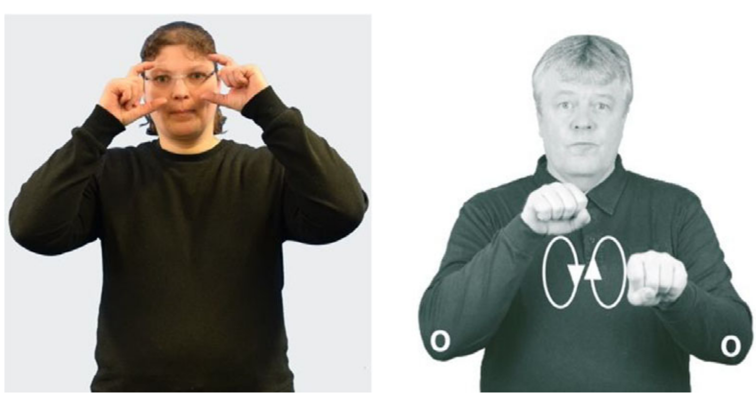
reduplication); in Figure 9b, this is illustrated for the noun CHILD. Note, finally, that simultaneous and backward reduplication may also combine, as for instance in the reciprocal form of GIVE, where the non-dominant hand simultaneously performs the backward movement – that is, the two hands move in opposite directions.

4.2 Theoretical account: Stochastic Optimality Theory

Having described different reduplication types, we now turn to a theoretical account of nominal plurals as the third (and last) illustration of how a theoretical model developed for the analysis of spoken languages – in this case, OT – can be applied to sign language data. To date, there are only a handful of studies that apply OT to sign language phenomena, and one of the earlier studies in this area is the one by Pfau and Steinbach (2005b) on the pluralization of nouns in DGS. In a nutshell, the authors observe that pluralization in DGS involves phonologically triggered allomorphy. That is, nouns can be grouped into four different classes on the basis of phonological properties, and class membership determines the pluralization strategy (note that the nouns we use as examples happen to have the same form in DGS and NGT):

- Midsagittal nouns (M-nouns) are articulated on the midline in front of the signer and form the plural via simple reduplication (e.g. HOUSE in Figure 8a).
- Lateral nouns (L-nouns) are articulated on the lateral side of the signing space and form the plural via sideward reduplication (e.g. PERSON in Figure 8b).
- Body-anchored nouns (B-nouns) are articulated in contact with or in relation to a body part and form the plural via zero marking (e.g. GLASSES in Figure 10a).[14]
- Nouns involving a complex (i.e. repeated, alternating and/or circular) movement (C-nouns) form the plural via zero marking (e.g. BIKE in Figure 10b).

We take Pfau and Steinbach's observations as a point of departure, but we do not discuss their formalization in detail. Suffice it to say that these authors assume that



(a) GLASSES (b) BIKE

Figure 10 DGS nouns that form their plural by means of zero marking: (a) the B-noun GLASSES; (b) the C-noun BIKE. Source: Finkbeiner and Pendzich (2021).

sideward reduplication is the basic reduplication strategy in DGS and that it may be partially or fully blocked because of various faithfulness and markedness constraints. Here are two examples. (i) Sideward reduplication is blocked for M-nouns because of an IDENT(F) constraint, which is violated if the midsagittal feature that characterizes M-nouns is lost in the output form; consequently the plural is formed by simple reduplication. (ii) A markedness constraint *[RED/BA] prohibits reduplication in nouns that are body-anchored; just like IDENT(F), this constraint is ranked higher than the MAX(IMIZE) constraints that require the overt realization of the plural feature, and consequently the plural form is realized by zero marking.

While the proposed formalization successfully accounts for the observed allomorphy, it is also rather simplistic, as it only considers input–output faithfulness but not base-reduplicant faithfulness, which plays an important role in OT accounts of reduplication in spoken languages (e.g. McCarthy and Prince 1999). More recently, van Boven et al. (2021) offered a more elaborate account of pluralization in NGT, an account based on naturalistic data from the Corpus NGT (Crasborn et al. 2008) as well as on elicited data. Like Pfau and Steinbach, they observe that different noun types favour different pluralization strategies; but, while Pfau and Steinbach report categorical patterns for DGS, van Boven et al. find (i) that there is considerable variation, as all noun types allow for at least two pluralization strategies, and (ii) that, for all noun types, one of these strategies is zero marking. That is, in contrast to DGS, B- and C-nouns allow for simple reduplication (for B-nouns, this is even the most common strategy), and overt pluralization is optional for all noun types.[15]

In order to capture the attested variation, van Boven et al. apply stochastic OT, a model that has been developed with the aim of accounting for variation in output forms (Boersma and Hayes 2001). In this framework, constraints are ranked along a continuous scale, and some small noise is added to the ranking value of each constraint at evaluation time. If two constraints C1 and C2 are rather distant from each other on the scale, the added noise will not have any impact; however, when they are closely ranked with respect to each other, the noise may result in a reverse ranking at a specific evaluation time. Over many evaluations, such cases result in multiple outputs for a single underlying form, that is, variation. Among the examples that Boersma and Hayes discuss to illustrate how their model works is plural marking in Ilokano. Example (10) illustrates that in this language the plural form of one and the same input noun may be realized by different types of reduplication.

(10)

pja.no 'piano' →
- (a) *pjan.pja.no* 'pianos'
- (b) *pi:.pja.no* 'pianos'
- (c) *pip.ja.no* 'pianos'

(Ilokano, Boersma and Hayes 2001, 56)

For NGT, van Boven et al. identify three phonological features that may be involved in the realization of the plural morpheme, namely [rep(etition)], which is responsible for simple reduplication, [side(ward)], which triggers sideward

Table 1 Possible pluralization strategies, given three privative features and their combinations. Realizations of feature combinations that did not occur in the NGT data are marked in grey.

Feature or feature combination	Phonological realization
Ø	zero marking
[rep]	simple reduplication
[side]	sideward movement
[sim]	simultaneous articulation
[rep, side]	sideward reduplication
[rep, sim]	simultaneous reduplication
[side, sim]	simultaneous sideward movement
[rep, side, sim]	simultaneous sideward reduplication

movement, and [sim(ultaneous)], which imposes the addition of the non-dominant hand. Including zero marking, the presence and combination of these privative features yields eight different phonological realizations, as shown in Table 1. However, four of these realizations were not (or only very infrequently) attested in the corpus and elicited data (shaded rows in the table).

Van Boven et al. propose a number of markedness constraints that exclude some of the non-attested realizations, but we will not go into these here. Rather we offer a sketch of how the model works by focusing on a single noun type, the class of B-nouns. For this reason, we introduce only the three constraints strictly relevant for the derivation of the plural form of B-nouns. First, there is the constraint REALIZE MORPHEME (REALIZE-μ), which requires all underlying morphemes to receive some phonological exponent (11a). This constraint (which is reminiscent of Pfau and Steinbach's MAX constraints) is satisfied 'as long as the candidate is not perfectly faithful to the form with which it is compared, where phonological non-identity is exactly what represents morphological contrasts' (Kurisu 2001, 39). Second, van Boven et al. invoke an alignment constraint ALIGN (STEM, L, PLURAL, L), short PLURAL-L, which requires the left edge of the plural morpheme to be realized as closely as possible to the left edge of the stem (11b) (cf. Riggle 2006). Invoking such a constraint is motivated by the fact that there is a tendency for morphemes to be realized simultaneously in sign languages (see Section 1). Clearly all candidates that involve the feature [rep], that is, sequential reduplication, violate this constraint, while the zero-marked candidate trivially satisfies it.[16]

(11) a. REALIZE-μ: The plural morpheme must have some kind of phonological exponent in the output.
b. PLURAL-L: The left edge of the plural must occur as closely as possible to the left edge of the stem.
c. IDENT-BR[body]: The feature [body] specified for the base may not be changed in the reduplicant.

Finally, the base–reduplicant faithfulness constraint in (11c) ensures that the lexically specified location feature [body] is not lost in the reduplicant – this constraint blocks sideward reduplication in body-anchored nouns, which indeed is not attested.

Table 2 Tableau showing example evaluation for the one-handed B-noun GLASSES; the learned ranking values are given on top of each constraint.

	100.30	99.68	−646.58
GLASSES + **[plural]**	REALIZE-μ	PLURAL-L	IDENT-BR**[body]**
a. GLASSES ∅	*!		
☞ b. GLASSES [rep]		*	
c. GLASSES $\begin{bmatrix}\text{rep}\\ \text{side}\end{bmatrix}$		*	*!
d. GLASSES $\begin{bmatrix}\text{rep}\\ \text{side}\\ \text{sim}\end{bmatrix}$		*	*!

Van Boven et al. then conducted a learning simulation using OTMulti grammar in Praat (Boersma and Weenink 2020). The initial grammar, which had no inherent ranking yet, was fed with 100 000 tokens of input–output pairs: the input consisted of one of the four NGT noun types, and the output was one of the plural realizations for the given input attested in the data – taking into account their actual distribution in the data (see n. 15, but note that the cases that occurred less than 5% of the time were also included in the simulation).

With the Gradual Learning Algorithm (Boersma and Hayes 2001), the grammar then stepwise learned a ranking that tried to replicate the actual distribution; during learning, constraints were promoted or demoted depending on the discrepancy between produced and expected output. After 100 000 learning steps, the newly learned grammar was evaluated by being fed 100 000 times input candidates, that is, one of the four noun types at a time. An example of the evaluation of the B-noun GLASSES (illustrated in Figure 10a) that involves the three constraints introduced in (11) is given in Table 2, with the learned ranking values on top of each constraint.[17]

Given this ranking, candidate (b), which marks the plural by simple reduplication, is the successful candidate. Crucially, however, the ranking values of the constraints REALIZE-μ and PLURAL-L are very close to each other, and both are very distant from the value of IDENT-BR[body]. In the spirit of stochastic OT, a small noise at the time of evaluation may result in a reverse ranking of these two constraints, and this reversal will give the zero-marked candidate (a) as output. In other words, the stochastic model gives us exactly the two plural forms that were attested in the data, but not the one with sideward reduplication that was not attested.

The example thus illustrates how stochastic OT can be successfully applied to a sign language to account for variation in output forms. On a larger scale, stochastic OT may well be a convenient model for sign language phenomena more generally, as sign languages have been shown to allow for variation in various domains of grammar. Another example from the domain of morphology, discussed previously in this chapter, is agreement. Recent corpus-based studies have found that the realization of agreement is optional in some sign languages. That is, even on those verbs that do allow for spatial modification to mark their subject or object (see Section 2.1), agreement is not always overtly realized (see De Beuzeville et al.

2009 for Australian Sign Language; Legeland 2016 for NGT; Fenlon et al. 2018 for British Sign Language; but see also Oomen 2020, who shows that the expression of subject and object agreement in DGS is almost obligatory).

5 Discussion: the impact of modality on morphology

This final section addresses two issues of a more general nature related to sign language morphology. First, Section 5.1 evaluates how sign languages fit into the categories developed in traditional morphological typology. Section 5.2 then briefly addresses the relationship between gesture and grammar, as agreement and classification in particular have been argued to have a gestural origin and to make use of gestural resources.

5.1 Morphological typology

Traditional morphological typology distinguishes four types of languages, depending on the way in which morphological information is organized: isolating, agglutinating, polysynthetic, and fusional languages (Comrie 1989). Comrie also acknowledges that very few languages, if any, adhere strictly to a single type. He therefore proposes two continua, which he refers to as 'indexes': the index of synthesis, which relates to the number of morphemes per word (12a), and the index of fusion, which describes the degree of fusion of units of meaning in a morpheme (12b).

(12) (a) Index of synthesis: isolating ⟷ polysynthetic
(b) Index of fusion: fusional ⟷ agglutinative

This raises the question of how far sign languages fit into this typological scheme, given the modality-specific features discussed in the preceding sections. Interestingly, different labels have been applied to sign languages in the literature. Erlenkamp (2000, 64), for instance, suggests that sign language morphosyntax is at the same time highly isolating and fusional – clearly a very unusual scenario from a typological perspective. We think, however, that both these classifications are wrong. For sure, a signed sentence can consist only of monomorphemic signs; but the same is true of English (e.g. 'Tomorrow the man will buy a book'), yet one would not classify English as an isolating language on account of this. The classification as fusional, on the other hand, is probably due to a confusion between simultaneous and fusional morphology. Fusional implies that meaning units cannot be assigned a dedicated phonological form (e.g. portmanteau morphemes; Comrie offers Russian case+number affixes as an example), but in most situations of simultaneous morphology in sign languages this clearly does not hold.[18] In the initial example in Figure 1b, for instance, every simultaneously realized morpheme can be linked to a phonological exponent (locations, handshape, non-manual marker).

The combination of morphological complexity and discreteness suggests that sign languages should rather be classified as agglutinative or polysynthetic languages (see Wallin 1996) with a modality-specific organization of morphemes. Let us illustrate this point with some examples. Turkish is the prototype of an agglutinative language that allows for words of considerable morphological complexity with clearly delineated boundaries between sequentially organized morphemes, as in (13).

(13) *bil-mek* ➔ *bil-mi-yor-um*
know-INF know-NEG-PRS-1SG
'to know' 'I don't know.'

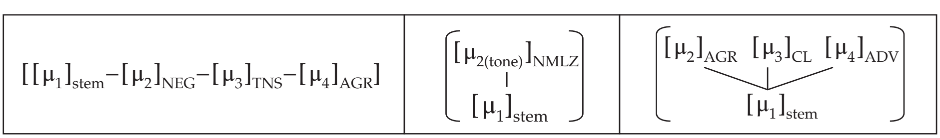
(Turkish)

However, even in spoken languages, it is not unusual for a morphological change to be realized through a stem-internal change. In German, pluralization usually involves suffixation, but some nouns form their plural through umlaut, that is, through the phonological feature [-back] (e.g. *Vater* 'father' ➔ *Väter* 'fathers'). In tone languages, tone changes may signal various inflectional or derivational processes. In Hausa, for instance, change from a high (H) to a falling (HL) tone indicates nominalization of certain verbs (14). Akinlabi (1996) refers to this change as a 'featural affixation' (his discussion extends to other features, such as [continuant], [labial] and [nasal]). In all the examples he discusses, the featural morphemes are readily identified, just as in the NGT example in Figure 1b.

(14) a. *sháa* (H) ➔ *shâa* (HL)
'to drink' 'drinking$_N$'
b. *cí* (H) ➔ *cîi* (HL)
'to eat' 'eating$_N$'

(Hausa; Newman 1992 in Yip 2002, 106)

We thus conclude that it is not the simultaneous realization of morphemes that is modality-specific. Rather, what appears to be modality-specific is the fact that multiple morphemes can be realized simultaneously. In other words the difference between the modalities is quantitative rather than qualitative. This difference is visualized in Figure 11, where horizontal arrangement implies sequential and vertical arrangement simultaneous realization of morphemes. In the NGT example in Figure 11c, three morphemes are realized simultaneously with the stem, whether by changing (location, handshape) or by adding (non-manual marker)[19] phonological features. A hypothetical parallel with a spoken language



(a) Turkish (b) Hausa (c) NGT

Figure 11 Visualization of different types of morphological complexity (μ = morpheme): (a) strictly sequential combination of morphemes in the Turkish example (13); (b) simultaneous realization of a tonal morpheme in the Hausa example (14); (c) simultaneous realization of multiple morphemes in NGT in the example in Figure 1b (simplified).

could look as follows: assume that the base form of the verb 'know' were *làb*, with a low tone on the vowel, and that the inflected form meaning 'He didn't know' were *lǟ́p*, where umlaut marked past tense, final devoicing marked third-person singular agreement, and high tone marked negation. This would present us with a morphological structure similar to the one in Figure 11c. To the best of our knowledge, no such forms are attested in spoken languages.

Given these typological facts, Schuit (2013) proposes to add an index of simultaneity alongside Comrie's (1989) indexes of fusion and synthesis (15c). Turkish would be located on the left side of the continuum, Hausa somewhat towards the centre, and NGT towards the right. Using data from Inuit Sign Language, Schuit further argues that, while all sign languages probably cluster towards the right end of the continuum, they need not occupy the exact same position on the index of simultaneity: some sign languages allow for more simultaneous morphological structure than others (see also n. 2).

(15)	(a)	Index of synthesis:	isolating	$\longleftrightarrow$	polysynthetic
	(b)	Index of fusion:	fusional	$\longleftrightarrow$	agglutinative
	(c)	Index of simultaneity:	sequential	$\longleftrightarrow$	simultaneous

5.2 The gesture–grammar interface

We have already mentioned that, across sign languages, morphological processes may draw on manual and non-manual gestural resources. Sign languages have gestural origins (Armstrong and Wilcox 2007; Corballis 2012) and integrate gestural components that iconically represent (or demonstrate) specific aspects of meaning. This modality-specific interaction of language and gesture is possible because sign language and (non-)manual gesture share the same modality.[20] Therefore sign languages cannot only be accompanied by co-speech gestures (Emmorey 1999). Gestures in sign languages, unlike gestures in spoken languages, may also become an integral part of the lexicon and of the grammatical system (Wilcox 2004; Pfau and Steinbach 2011; van Loon et al. 2014), that is, gestures contribute to the meaning of utterances in a more systematic way than in spoken languages (see e.g. Schlenker 2018; Steinbach 2021). Moreover, gestures have been shown to constitute the basis of a specific kind of language emergence: co-speech gestures form the basis of home sign systems, which may, under certain circumstances, develop into full-blown sign languages (Brentari and Goldin-Meadow 2017; Goldin-Meadow and Brentari 2017; Kocab and Senghas 2021; Sandler 2021).

In this final section we briefly discuss the impact of gestural resources on two of the three inflectional processes discussed in this chapter: agreement and predicate classifiers. The third process, reduplication, also has a clear gestural component – as seen for example in the transparent form–meaning relationship of reduplication in the context of pluralization. However, unlike spatial agreement and classifying handshapes, reduplication is used as a morphological strategy in pretty much the same way in spoken languages (Section 4.1). Consequently reduplication as a morphological process is not modality-specific, but, as we have shown, specific surface realizations of reduplication may be.

Given the modality-specific interaction between gesture and sign language, it is not surprising that alternative accounts have been put forward that highlight the gestural components of agreement and classifiers (Liddell 2003; Schembri et al. 2005; Schembri et al. 2018). Although we think that each morphosyntactic analysis of inflection in sign languages should take potential gestural ingredients seriously, we don't think that formal (generative) analyses and more gesturally oriented approaches are mutually exclusive. The general aim of both approaches should be the development of an integral theory of the interaction of linguistic and gestural components in different communicative settings that accounts for modality-specific as well as for modality-independent aspects of visual communication (e.g. Goldin-Meadow and Brentari 2017).

Consider predicate classifiers first. In a cross-linguistic study on three unrelated sign languages (Australian Sign Language, Taiwan Sign Language, and ASL) as well as on gestural productions of hearing non-signers, Schembri et al. (2005) found that, with entity classifiers, the handshape used to depict a specific entity is subject to typological variation. In Figure 12, this variation is illustrated with classifier handshapes for vehicles, as used in ASL, DGS and Jordanian Sign Language (LIU).

At the same time, signers of the same sign language did not show much variation in the form of the handshapes they used. In addition, these handshapes did not correspond to handshapes used by hearing non-signers when asked to describe the same event in silent gestures. These findings strongly suggest that the paradigm of entity classifiers is categorial and less iconic. By contrast, the movement and location features used to demonstrate the movement or location of the corresponding vehicle in space did not show any variation across the three sign languages; moreover, the distribution of these features corresponded to silent gestures produced by the hearing non-signers. These two features are thus less categorial and more iconic.

With handling classifiers, even the handshape has gestural properties. Handling classifiers are typically used to demonstrate specific aspects of an action from the perspective of the acting character (Perniss 2007; Herrmann and Pendzich 2018). Depending on the kind of demonstration, all three features – handshape, movement, and location – are accessible for gestural demonstrations (see e.g. Davidson 2015; Kimmelman et al. 2020). Consider the example in Figure 1b again. The handshape can be modified to depict the shape, size and weight of the object of the transfer event. In addition, the demonstration can involve one or two hands to

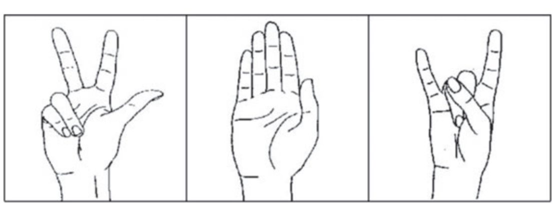


Figure 12 Entity classifiers for vehicles in three different sign languages; note that in ASL and LIU, the orientation of the palm is vertical, while in DGS, it is downward. Source: Perniss et al. (2007, 10).

depict the handling of the object. Likewise, location and movement features, as well as non-manual markers, can be manipulated to adapt the demonstration to the depicted event. Therefore Brentari and Padden (2001) argue that only specific aspects of classifiers (and lexicalized classifier constructions) enter the core lexicon, while other components, which are mainly used in (more gestural) depictive constructions, are part of a productive or non-core lexicon integrating gestural components. Consequently Sandler (2021) speaks of 'morpheme–gesture hybrids' in this context (see also Cogill-Koez 2000 and Cormier et al. 2012).

Like classifiers, verb–argument agreement has a gestural origin, which is still visible in grammaticalized agreement systems such as the one described for DGS.[21] The prototypical agreement verb is the ditransitive transfer predicate GIVE, which expresses the physical transfer of an object in space: this means that, with GIVE, the path movement may gesturally depict the transfer of the object from one person to another (Steinbach 2011). Not surprisingly, the spatial modification of this verb is attested in most sign languages. The gestural origin is also visible in backwards verbs, which describe a physical movement relation of an entity from the locus of the object to the locus of the subject. A third domain of gestural impact on agreement is the modification of the movement component, which is not restricted to the horizontal plane. A modification of the movement and location features on the vertical plane can, for instance, be used to express iconically a difference in body height or social hierarchy between the referent of the subject and the referent of the object (Barberà 2012; Schlenker et al. 2013). Like the movement and location features of entity classifiers, the movement and location features of agreement verbs are accessible to a gestural demonstration of specific aspects of the event.

But the fact that classifiers and agreement have gestural origins and integrate gestural components does not mean that these two morphological processes are entirely gestural. Both classifiers and agreement are subject to the morphosyntactic restrictions described here. Moreover, in grammaticalized agreement systems, many, if not most, agreement verbs do not express a concrete transfer relation, that is, the gesturally motivated movement may turn into a grammatically determined relation used to express morphosyntactic agreement controlled by two arguments of the verb. And finally, many sign languages show a systematic development towards a more grammaticalized agreement system. On the one hand, plain verbs may turn into agreement verbs by eliminating the relevant phonological specifications (Meir 2016). On the other hand, many sign languages have developed dedicated functional signs, such as the DGS auxiliary PAM described in Section 2.1, to realize agreement with plain verbs. These agreement auxiliaries follow specific grammaticalization paths that, again, combine modality-independent and modality-specific aspects (Steinbach and Pfau 2007; Pfau and Steinbach 2013; Steinbach 2022).

6 Conclusion

This entry offered a typological and theoretical perspective on sign language morphology by examining in some detail the morphophonological realization of three inflectional categories: agreement, predicate classifiers and pluralization. As for the typological side, this discussion shows that sign languages employ the same strategies for morphological modification as spoken languages do: morphological processes may be realized sequentially, by affixation or reduplication, or by means of simultaneous changes, such as stem-internal or suprasegmental modification, which are comparable to ablaut phenomena and tonal morphemes in spoken languages. However, the distribution of sequential versus simultaneous processes appears to be modality-specific. While sequential affixation is attested in sign languages, it is rare and for the most part restricted to the domain of derivation (see also Aronoff et al. 2005). Simultaneously realized modifications, which may affect all the phonological building blocks of signs, are much more common – and, what is more, multiple simultaneous changes may apply to a single stem, yielding a multi-morphemic yet monosyllabic sign. Even reduplication, typically a sequential process, may be realized simultaneously, thanks to the affordances of the visual–spatial modality, that is, the availability of a second articulator, the non-dominant hand.

As for the theoretical perspective, the work presented here demonstrates that the morphological processes under discussion can be accounted for within different formal linguistic theories that have been developed on the basis of spoken language data: minimalism (for agreement), DM (for predicate classifiers), and OT (for plural marking). Thus – notwithstanding the modality-specific peculiarities of sign language morphology discussed earlier – the picture that emerges tells us that the theoretical concepts and mechanisms that these models rely on (e.g. the operation Agree, late insertion, and constraint ranking) allow for the modality-independent implementation of inflectional categories in spoken and sign languages. In other words, accounting for the grammatical core of sign language morphology does not require theoretical models tailored to the visual–spatial modality.[22] Likewise, the modality-specific interaction between morphology and phonology described earlier, yielding as it does the simultaneous expression of certain morphological features, is readily implemented in existing theories. Nevertheless, the impact of gestures on sign language morphology calls for a 'gestural upgrade' of the classical generative theories developed for spoken languages in order to account for the gestural origins of morphological processes and the modality-specific integration of gestural components in agreement and classifier constructions (Goldin-Meadow and Brentari 2017).

Altogether, the discussion strongly suggests that languages in both modalities draw on the same resources, which are provided by a modality-independent universal grammar. On the typological side, these resources include various processes available for morphological modification; on the theoretical side, they draw on (theory-dependent) grammatical mechanisms required for deriving and selecting the surface form of inflectional categories.

In conclusion to this entry, it should be pointed out that, beyond the realm of morphology, similar arguments have been put forward for various semantic and syntactic phenomena, including anaphora (e.g. Steinbach and Onea 2016) and negation. Take the latter as an example. On the typological side, it has been proposed that some sign languages display French-like split negation when clausal negation is systematically realized by an optional manual particle (i.e. a sign that can be glossed as NOT) and by an obligatory non-manual marker (a headshake), which behaves like a simultaneous affix and attaches to the verb. Still, it is also clear that sign languages, just like spoken languages, may differ from each other typologically in this domain (Zeshan 2004; Oomen and Pfau 2017). As for theoretical accounts, various authors have argued that the interaction of different types of negative markers can be accounted for within generative models, which assume the projection of a negative phrase and the checking of (un)interpretable features associated with negative markers (Pfau 2016c; see Gökgöz 2021 for a recent overview). Still, it is important to emphasize that the cross-modal application of typological and theoretical concepts and constructs should not be taken to imply that language modality does not impact the surface realization of grammatical categories at all – as is also evident from the three domains discussed in this entry.

SEE ALSO: Ablaut; Agent Nominalizations; Agreement and the Realization of Arguments; Multiple and Cumulative Exponence; Reduplication; Rich Agreement and Verb Movement; Word-internal Inflection.

Acknowledgements

We are indebted to Nina-Kristin Pendzich, Marijke Scheffener and Thomas Finkbeiner for assistance with the sign language examples. For cooperation and feedback on parts of this chapter, we thank Cindy van Boven and Silke Hamann. Finally, we much appreciated the constructive feedback of our editor Antonio Fabregas – as well as his patience.

Notes

1. The LML sequence is often considered to be the sign language equivalent of a syllable, the M-segment constituting the syllable nucleus (e.g. Perlmutter 1992; Brentari 1998). It has been observed that there is a tendency for signs, even morphologically complex ones, to be monosyllabic, a phenomenon that has been referred to as the 'monosyllable conspiracy' (Sandler 1999, 2008; Goldin-Meadow and Brentari 2017).
2. Aronoff et al. (2005) actually use the term 'universal', but more recent studies – in particular studies on rural sign languages – indicate that sign languages may differ from one another with respect to simultaneously realized morphological processes (e.g. agreement and classifier morphology, to be discussed respectively in Sections 2 and 3); see de Vos and Pfau (2015) and references therein.
3. Compounds are interesting, as they are typically characterized by phonological processes of reduction and assimilation, that is, they display sequential and simultaneous properties; for description and theoretical accounts, see e.g. Klima and Bellugi (1979), Liddell and Johnson (1986), Meir et al. (2010), Vercellotti and Mortensen (2012), and Santoro (2018).
4. In sign language linguistics, the term 'modality' is commonly used to refer to the channel of signal transmission (production and perception). As opposed to spoken languages, which employ the oral–auditory modality, sign languages employ the visual–spatial modality, as they are produced with the hands, arms, upper part of the body, head, and face and are perceived with the eyes. For similarities and differences between the modalities, see Meier (2002, 2012).

5. The issue of optionality is briefly addressed at the end of Section 4. In Section 5.2 we discuss the interaction of gesture and sign language and the grammaticalization of agreement and agreement markers in sign languages in more detail. For a differential object-marking account of object agreement in sign languages, see Börstell (2019), Bross (2020), and Steinbach (2022).
6. Following standard conventions, signs are glossed in SMALL CAPS; when two words are necessary for glossing the meaning of a single sign, a period is used (e.g. MOVE.DOWN). INDEX refers to a pointing sign, usually executed with the extended index finger; POSS is a possessive pronoun (articulated with a flat hand in DGS). The gloss CL is used for classifier handshapes; this gloss is combined with a specification of the relevant semantic characteristics of the argument that is classified (e.g. CL:flat). Subscripts accompanying INDEX and certain verbs refer to loci in the signing space in front of the signer, where '1' is a locus close to the signer's body (first person), and '3a/3b' are loci in the right–left frontal area of the signing space (third person).
7. Note that Oomen (2020) argues that in DGS at least intransitive plain verbs express agreement with the only argument, the subject of the sentence. The agreement marker is realized either by the body of the signer (with plain verbs that are produced on, or close to, the body) or by an R-locus in the neutral signing space (with plain verbs that are produced in the neutral signing space). For a similar analysis of plain verbs in Spanish Sign Language and Brazilian Sign Language, see Costello (2015) and Lourenço (2018).
8. Note that PAM is subject to syntactic variation. In certain DGS varieties, PAM preferably occurs in preverbal position (Macht and Steinbach 2019). Bross (2020) and Steinbach (2022) argue that preverbal PAM is not an agreement marker but a nominal differential object marker.
9. For an overview and a critical discussion of the different analyses, see Pfau et al. (2018). We return to gestural accounts and the impact of gestures on agreement in Section 5.2.
10. See Schembri (2003) and Zwitserlood (2012) for alternative classifications and terminology. Note also that we will not address complex classifier constructions in which the two hands are used for visualizing the spatial relationship between two entities, e.g. 'person next to a car' or 'book on top of a table' (see Pfau and Aboh 2012 for a formal account of such constructions).
11. In our discussion in Section 3.1 we neglected a third classifier type, namely bodypart classifiers, which have been argued to classify the external argument of unergative predicates (Glück and Pfau 1998; Benedicto and Brentari 2004; but see Grose et al. 2007 for an alternative proposal). Moreover, recent studies on various sign languages indicate that the relation between argument structure and classifier type is not as clear-cut as originally thought (de Lint 2018; Kimmelman et al. 2019; Tang et al. 2021).
12. Mathur (2000), working also within DM, suggests that spatial agreement involves phonological readjustment as well. He assumes that agreeing verbs are lexically specified for beginning and end point and proposes a readjustment rule called 'Align Stem' that 'rotate[s] the whole sign in such a way that endpoint X is aligned with the subject locus and endpoint Y is aligned with the object locus' (Mathur 2000, 116).
13. For the sake of consistency throughout the chapter, and since we neglected some complexities, we slightly deviate in (8) from Zwitserlood's presentation, first with respect to the form of the handling classifier in (8b), and second with respect to the relevant features (see Zwitserlood 2003, 192–195 for the feature inventory she proposes).
14. In both DGS and NGT, the sign GLASSES can be produced with either one or two hands. While DGS seems to prefer the two-handed variant illustrated in Figure 4a, in NGT the one-handed variant is the preferred one.

15. The study is based on a total of 486 plural nouns: 297 from the corpus and 189 elicited by means of a gap-filling task (51 noun types in total). The distribution of pluralization strategies is as follows (only strategies used in > 5% of the cases are provided):

    M-nouns: 43.2% zero marking, 29.7% simple and 21.6% sideward reduplication;
    L-nouns: 15.6% zero marking, 67.9% sideward and 12.9% simultaneous sideward reduplication;
    B-nouns: 40.2% zero marking and 55.7% simple reduplication;
    C-nouns: 57.5% zero marking and 37.5% simple reduplication.

16. The candidate that involves only the feature [sim], that is, simultaneous reduplication by means of the non-dominant hand, also satisfies this constraint. As shown in Table 1, this form was not attested in the data, and van Boven et al. (2021) exclude it by means of another markedness constraint, which blocks the purely simultaneous realization of the plural feature.
17. Van Boven et al. (2021) also calculated the output frequencies produced by this learned grammar for each noun type. For B-nouns, this turned out to be 41.3% zero marking and 58.7% simple reduplication, and these percentages are very close to the actual distribution in the data (see n. 15).
18. An exception is, for instance, the suppletive forms of negative modals that have been described for various sign languages; see Quer (2012) for an overview.
19. See Pfau (2016b) for a comprehensive comparison of non-manual markers and tone.
20. Since spoken languages share the same modality with auditory gestures, a comparable interaction between spoken languages and gestures is possible in the auditory–oral modality. On the one hand, speakers may modulate their voice to demonstrate certain aspects of the event described. On the other hand, auditory gestures may be integrated into the linguistic system of spoken languages. Two prominent examples are intonation and ideophones (Gussenhoven 2004; Dingemanse and Akita 2017).
21. Pfau and Steinbach (2011) hypothesize that spatial agreement in sign languages may be traced back to pointing gestures that have been grammaticalized to pronouns. In this scenario, pronominal pointing signs that are phonologically reduced cliticize to the verb and develop into (spatial) agreement affixes that specify the L-slots of the verb stem.
22. Even scholars who emphasize the role of gestural resources in synchronic sign language grammar apply models developed for spoken languages, namely models couched within the framework of cognitive grammar, such as mental space theory (Fauconnier 1997).

References

Abner, Natasha. 2017. 'What You See Is What You Get.Get: Surface Transparency and Ambiguity of Nominalizing Reduplication in American Sign Language'. *Syntax*, 20 (4): 317–352.

Aikhenvald, Alexandra Y. 2000. *Classifiers: A Typology of Noun Categorization Devices*. Oxford: Oxford University Press.

Aissen, Judith. 2003. 'Differential Object Marking: Iconicity vs. Economy, *Natural Language and Linguistic Theory*, 21: 435–483.

Akinlabi, Akinbiyi. 1996. 'Featural Affixation'. *Journal of Linguistics*, 32: 239–289.

Allan, Keith. 1977. 'Classifiers'. *Language*, 53 (2): 285–311.

Armstrong, David, and Sherman E. Wilcox. 2007. *The Gestural Origin of Language*. Oxford: Oxford University Press.

Aronoff, Mark, Irit Meir, and Wendy Sandler. 2005. 'The Paradox of Sign Language Morphology'. *Language*, 81 (2): 301–344.

Barberà, Gemma. 2012. 'The Meaning of Space in Catalan Sign Language (LSC): Reference, Specificity and Structure in Signed Discourse'. PhD diss., Universitat Pompeu Fabra, Barcelona.

Benedicto, Elena, and Diane Brentari. 2004. 'Where Did All the Arguments Go? Argument-changing Properties of Classifiers in ASL'. *Natural Language & Linguistic Theory*, 22: 743–810.

Bergman, Brita, and Östen Dahl. 1994. 'Ideophones in Sign Language? The Place of Reduplication in the Tense–Aspect System of Swedish Sign Language'. In *Tense, Aspect and Action: Empirical and Theoretical Contributions to Language Typology*, edited by Carl Bache, Hans Basbøll, and Carl-Erik Lindberg, 397–422. Berlin: Mouton de Gruyter.

Blust, Robert. 2014. 'Austronesian'. In *The Oxford Handbook of Derivational Morphology*, edited by Rochelle Lieber and Pavol Štekauer, 545–557. Oxford: Oxford University Press.

Boersma, Paul, and Bruce Hayes. 2001. 'Empirical Tests of the Gradual Learning Algorithm'. *Linguistic Inquiry*, 32 (1): 45–86.

Boersma, Paul, and David Weenink. 2020. *Praat: Doing Phonetics by Computer*. Version 6.1.27. www.praat.org.

Börstell, Carl. 2019. 'Differential Object Marking in Sign Languages'. *Glossa: A Journal of General Linguistics*, 4 (1): 3, 1–18.

Bossong, Georg. 1991. 'Differential Object Marking in Romance and Beyond'. In *New Analyses in Romance Linguistics*, edited by Dieter Wanner, and Douglas A. Kibbee, 143–170. Amsterdam: John Benjamins.

Brentari, Diane. 1998. *A Prosodic Model of Sign Language Phonology*. Cambridge, MA: MIT Press.

Brentari, Diane. 2012. 'Phonology'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach, and Bencie Woll, 21–54. Berlin: De Gruyter Mouton.

Brentari, Diane, and Susan Goldin-Meadow. 2017. 'Language emergence'. *Annual Review of Linguistics*, 3: 363–388.

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

Bross, Fabian. 2020. 'Object Marking in German Sign Language (Deutsche Gebärdensprache): Differential Object Marking and Object Shift in the Visual Modality'. *Glossa: A Journal of General Linguistics*, 5 (1): 1–37.

Chomsky, Noam. 2000. 'Minimalist Inquiries: The Framework'. In *Step by Step: Essays on Minimalist Syntax in Honor of Howard Lasnik*, edited by Roger Martin, David Michaels and Juan Uriagereka, 89–156. Cambridge, MA: MIT Press.

Cogill-Koez, Dorothea. 2000. 'Signed Language Classifier Predicates: Linguistic Structures or Schematic Visual Representation?' *Sign Language & Linguistics*, 3 (2): 153–207.

Comrie, Bernard. 1989. *Language Universals and Linguistic Typology*, vol. 2. Chicago, IL: University of Chicago Press.

Corballis, Michael C. 2012. 'How Language Evolved from Manual Gestures'. *Gesture*, 12 (2): 200–226.

Cormier, Kearsy, David Quinto-Pozos, Zed Sevcikova and Adam Schembri. 2012. 'Lexicalisation and De-lexicalisation Processes in Sign Languages: Comparing Depicting Constructions and Viewpoint Gestures'. *Language & Communication*, 32: 329–348.

Costello, Brendan D.N. 2015. 'Language and Modality: Effects of the Use of Space in the Agreement System of Lengua de Signos Española (Spanish Sign Language)'. PhD diss., University of Amsterdam & University of the Basque Country.

Crasborn, Onno, Inge Zwitserlood and Johan Ros. 2008. *The Corpus NGT: A Digital Open Access Corpus of Movies and Annotations of Sign Language of the Netherlands*. http://hdl.handle.net/hdl:1839/00-0000-0000-0004-DF8E-6.

Davidson, Kathryn. 2015. 'Quotation, Demonstration, and Iconicity'. *Linguistics and Philosophy*, 38 (6): 477–520.

De Beuzeville, Louise, Trevor Johnston and Adam Schembri. 2009. 'The Use of Space with Indicating Verbs in Auslan: A Corpus-based Investigation'. *Sign Language & Linguistics*, 12 (1): 53–82. DOI: 10.1075/sll.12.1.03deb.

de Lint, Vanja. 2018. 'NGT Classifier Constructions: An Inventory of Arguments.' *Sign Language & Linguistics*, 21 (1): 3–39. DOI: 10.1075/sll.00011.lin.

de Vos, Connie, and Roland Pfau. 2015. 'Sign Language Typology: The Contribution of Rural Sign Languages'. *Annual Review of Linguistics*, 1: 265–288. DOI: 10.1146/annurev-linguist-030514-124958.

Dingemanse, Mark, and Kimi Akita. 2017. 'An Inverse Relation between Expressiveness and Grammatical Integration: On the Morphosyntactic Typology of Ideophones, with Special Reference to Japanese'. *Journal of Linguistics*, 53 (3): 501–532.

Dingemanse, Mark, Damián E. Blasi, Gary Lupyan, Morten H. Christiansen and Padraic Monaghan. 2015. 'Arbitrariness, Iconicity, and Systematicity in Language'. *Trends in Cognitive Sciences*, 19 (1): 603–615. DOI: 10.1016/j.tics.2015.07.013.

Emmorey, Karen. 1999. 'Do Signers Gesture?' In *Gesture, Speech, and Sign*, edited by Lynn S. Messing and Ruth Campbell, 133–159. Oxford: Oxford University Press.

Erlenkamp, Sonja. 2000. *Syntaktische Kategorien und lexikalische Klassen: Typologische Aspekte der Deutschen Gebärdensprache*. Munich: Lincom Europa.

Ezard, Bryan. 1997. *A Grammar of Tawala, an Austronesian Language of the Milne Bay Area, Papua New Guinea.* Canberra: Australian National University.

Fauconnier, Gilles. 1997. *Mapping in Thought and Language*. Cambridge: Cambridge University Press.

Fenlon, Jordan, Adam Schembri and Kearsy Cormier. 2018. 'Modification of Indicating Verbs in British Sign Language: A Corpus-based Study'. *Language*, 94: 84–118. DOI: 10.1353/lan.2018.0002.

Finkbeiner, Thomas, and Nina-Kristin Pendzich. 2021. *Sprachkalender der Deutschen Gebärdensprache*. Hamburg: Buske.

Fischer, Susan D. 1973. 'Two Processes of Reduplication in the American Sign Language'. *Foundations of Language*, 9: 469–480.

Fornasiero, Elena. 2020. 'Description and Analysis of Evaluative Constructions in Italian Sign Language (LIS)'. PhD diss., Ca' Foscari University, Venice.

Glück, Susanne, and Roland Pfau. 1998. 'On Classifying Classification as a Class of Inflection in German Sign Language'. In *Proceedings of ConSole 6*, edited by Tina Cambier-Langeveld, Aniko Lipták and Michael Redford, 59–74.

Glück, Susanne, and Roland Pfau. 1999. 'A Distributed Morphology Account of Verbal Inflection in German Sign Language'. In *Proceedings of ConSole 7*, edited by Tina Cambier-Langeveld, Aniko Lipták, Michael Redford and Eric-Jan van der Torre, 66–80.

Gökgöz, Kadir. 2021. 'Negation: Theoretical and Experimental Perspectives'. In *The Routledge Handbook of Theoretical and Experimental Sign Language Research*, edited by Josep Quer, Roland Pfau and Annika Herrmann, 266–294. Oxford: Routledge.

Goldin-Meadow, Susan, and Diane Brentari. 2017. 'Gesture, Sign, and Language: The Coming of Age of Sign Language and Gesture Studies'. *Behavioral and Brain Sciences*, 40: 1–60.

Grose, Donovan, Ronnie B. Wilbur and Katharina Schalber. 2007. 'Events and Telicity in Classifier Predicates: A Reanalysis of Body Part Classifier Predicates in ASL'. *Lingua*, 117: 1258–1284.

Gussenhoven, Carlos. 2004. *The Phonology of Tone and Intonation*. Cambridge: Cambridge University Press.

Halle, Morris, and Alec Marantz. 1993. 'Distributed Morphology and the Pieces of Inflection'. In *The View from Building 20: Essays in Linguistics in Honour of Sylvain Bromberger*, edited by Ken Hale and Samuel J. Keyser, 111–176. Cambridge, MA: MIT Press.

Harley, Heidi, and Rolf Noyer. 2003. 'Distributed Morphology'. In *The Second Glot International State-of-the-article Book*, edited by Lisa Cheng and Rynt Sybesma, 463–496. Berlin: Mouton de Gruyter.

Harrison, David. 2000. Topics in the Phonology and Morphology of Tuvan. PhD Diss., Yale University.

Haspelmath, Martin. 2005. 'Argument Marking in Ditransitive Alignment Types'. *Linguistic Discovery*, 3 (1): 1–21.

Herrmann, Annika, and Nina-Kristin Pendzich. 2018. 'Between Narrator and Protagonist in Fables of German Sign Language'. In *Linguistic Foundations of Narration in Spoken and Sign Languages*, edited by Annika Hübl and Markus Steinbach, 275–308. Amsterdam: John Benjamins.

Kimmelman, Vadim. 2009. 'Parts of Speech in Russian Sign Language: The Role of Iconicity and Economy'. *Sign Language & Linguistics*, 12 (2): 161–186.

Kimmelman, Vadim, Vanja de Lint, Connie de Vos, Marloes Oomen, Roland Pfau, Lianne Vink and Enoch O. Aboh. 2019. 'Argument Structure of Classifier Predicates: Canonical and Non-canonical Mappings in Four Sign Languages'. *Open Linguistics*, 5: 332–353. DOI: 10.1515/opli-2019-0018.

Kimmelman, Vadim, Roland Pfau and Enoch O. Aboh. 2020. 'Argument Structure of Classifier Predicates in Russian Sign Language'. *Natural Language and Linguistic Theory*, 38: 539–579. DOI: 10.1007/s11049-019-09448-9.

Klima, Edward, and Ursula Bellugi. 1979. *The Signs of Language*. Cambridge, MA: Harvard University Press.

Klomp, Ulrika. 2021. 'A Descriptive Grammar of Sign Language of the Netherlands'. PhD diss., University of Amsterdam.

Kocab, Annemarie, and Ann Senghas. 2021. 'Language Emergence: Theoretical and Experimental Perspectives'. In *The Routledge Handbook of Theoretical and Experimental Sign Language Research*, edited by Josep Quer, Roland Pfau and Annika Herrmann, 636–663. Oxford: Routledge.

Kubus, Okan, and Annette Hohenberger. 2013. 'The Phonology and Phonetics of Reciprocals in Turkish Sign Language (TİD)'. In *Current Directions in Turkish Sign Language Research*, edited by Engin Arık, 101–141. Newcastle upon Tyne: Cambridge Scholars Publishing.

Kurisu, Kazutaka. 2001. 'The Phonology of Morpheme Realization'. PhD diss., University of California Santa Cruz.

Legeland, Iris. 2016. 'Congruentie in de Nederlandse Gebarentaal: Een Corpus-gebaseerd Onderzoek' ['Agreement in Sign Language of the Netherlands: A Corpus-based Study']. BA thesis, University of Amsterdam.

Liddell, Scott K. 1980. *American Sign Language Syntax*. The Hague: Mouton.

Liddell, Scott K. 2003. *Grammar, Gesture, and Meaning in American Sign Language*. Cambridge: Cambridge University Press.

Liddell, Scott K., and Robert E. Johnson. 1986. 'American Sign Language Compound Formation Processes, Lexicalization, and Phonological Remnants'. *Natural Language and Linguistic Theory*, 4: 445–513.

Lillo-Martin, Diane, and Richard P. Meier. 2011. 'On The Linguistic Status of "Agreement" in Sign Languages'. *Theoretical Linguistics*, 37 (3/4): 95–141. DOI: 10.1515/thli.2011.009.

Lourenço, Guilherme. 2018. 'Verb Agreement in Brazilian Sign Language: Morphophonology, Syntax, and Semantics'. PhD diss., Universidade Federal de Minas Gerais, Belo Horizonte.

Macht, Claudia, and Markus Steinbach. 2019. 'Regionalsprachliche Merkmale in der Deutschen Gebärdensprache'. In *Sprache und Raum; Ein Internationales Handbuch der Sprachvariation*, edited by Joachim Herrgen and Jürgen Erich Schmidt, 914–935. Berlin: De Gruyter Mouton.

Makharoblidze, Tamar. 2015. 'Indirect Object Markers in Georgian Sign Language'. *Sign Language & Linguistics*, 18 (2): 238–250.

Mathur, Gaurav. 2000. 'Verb Agreement as Alignment in Signed Languages'. PhD diss., MIT, Cambridge, MA.

Mathur, Gaurav, and Christian Rathmann. 2012. 'Verb Agreement'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 136–157. Berlin: De Gruyter Mouton.

McCarthy, John J., and Alan Prince. 1999. 'Faithfulness and Identity in Prosodic Morphology'. In *The Prosody–Morphology Interface*, edited by Rene Kager, Harry van der Hulst and Wim Zonneveld, 218–309. Cambridge: Cambridge University Press.

Meier, Richard P. 2002. 'Why Different, Why the Same? Explaining Effects and Non-effects of Modality upon Linguistic Structure in Sign and Speech'. In *Modality and Structure in Signed and Spoken Languages*, edited by Richard P. Meier, Kearsy Cormier and David Quinto-Pozos, 1–25. Cambridge: Cambridge University Press.

Meier, Richard P. 2012. 'Language and Modality'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 574–601. Berlin: De Gruyter Mouton.

Meir, Irit. 2001. 'Verb Classifiers as Noun Incorporation in Israeli Sign Language'. In *Yearbook of Morphology 1999*, edited by Geert Booij and Jaap van Marle, 299–319. Dordrecht: Kluwer.

Meir, Irit. 2002. 'A Cross-modality Perspective on Verb Agreement'. *Natural Language and Linguistic Theory*, 20: 413–450.

Meir, Irit. 2012. 'Word Classes and Word Formation'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 77–112. Berlin: De Gruyter Mouton.

Meir, Irit. 2016. 'Grammaticalization Is Not the Full Story: A Non-grammaticalization Account of the Emergence of Sign Language Agreement Morphemes'. In *MMM10 Online Proceedings*, edited by Jenny. Audring, Francesca. Masini and Wendy. Sandler, 112–124.

Meir, Irit, Mark Aronoff, Wendy Sandler and Carol Padden. 2010. 'Sign Languages and Compounding'. In *Cross-Disciplinary Issues in Compounding*, edited by Sergio Scalise and Irene Vogel, 301–322. Amsterdam: John Benjamins.

Mithun, Marianne. 1984. 'The Evolution of Noun Incorporation'. *Language*, 60 (4): 847–894.

Mithun, Marianne. 1986. 'The Convergence of Noun Classification Systems'. In *Noun Classes and Categorization*, edited by Colette Craig, 379–397. Amsterdam: John Benjamins.

Newman, Paul. 1992.'The Development of Falling Contours from Tone Bending in Hausa'. In *Proceedings of the Berkeley Linguistics Society, Special Session on the Typology of Tone Languages*, edited by Laura A. Buszard-Welcher, Jonathan Evans, David Peterson, Lionel Wee and William Weigel, 128–133. Berkeley, CA: Berkeley Linguistics Society.

Nevins, Andrew. 2011. 'Prospects and Challenges for a Clitic Analysis of (A)SL Agreement'. *Theoretical Linguistics*, 37: 173–187. DOI: 10.1515/thli.2011.013.

Oomen, M. 2020. 'Iconicity as a Mediator between Verb Semantics and Morphosyntactic Structure: A Corpus-based Study on Verbs in German Sign Language'. PhD diss., University of Amsterdam.

Oomen, Marloes, and Roland, Pfau 2017. 'Signing NOT (or Not): A Typological Perspective on Standard Negation in Sign Language of the Netherlands'. *Linguistic Typology*, 21 (1): 1–51.

Padden, Carol A. 1988. *Interaction of Morphology and Syntax in American Sign Language*. New York: Garland Publishing. Reissued 2017, London: Routledge.

Padden, Carol A., and David M. Perlmutter. 1987. 'American Sign Language and the Architecture of Phonological Theory'. *Natural Language and Linguistic Theory*, 5: 335–375.

Pendzich, Nina. 2020. *Lexical Nonmanuals in German Sign Language: Empirical Studies and Theoretical Implications*. Berlin: De Gruyter Mouton.

Perlmutter, David M. 1992. 'Sonority and Syllable Structure in American Sign Language'. *Linguistic Inquiry*, 23 (3): 407–442.

Perniss, Pamela. 2007. 'Space and Iconicity in German Sign Language (DGS)'. PhD diss., University of Nijmegen.

Perniss, Pamela, Roland Pfau and Markus Steinbach. 2007. 'Can't You See the Difference? Sources of Variation in Sign Language Structure'. In *Visible Variation: Comparative Studies on Sign Language Structure*, edited by Pamela Perniss, Roland Pfau and Markus Steinbach, 1–34. Berlin: Mouton de Gruyter.

Pfau, Roland. 2016a. 'Morphology'. In *The Linguistics of Sign Languages: An Introduction*, edited by Anne Baker, Beppie van den Bogaerde, Roland Pfau and Trude Schermer, 197–228. Amsterdam: John Benjamins.

Pfau, Roland. 2016b. 'Non-manuals and Tones: A Comparative Perspective on Suprasegmentals and Spreading'. *Revista de Estudos Linguísticos da Universidade do Porto*, 11: 19–58.

Pfau, Roland. 2016c. 'A Featural Approach to Sign Language Negation'. In *Negation and Negative Polarity: Cognitive and Experimental Perspectives*, edited by Pierre Larrivée and Chungmin Lee, 45–74. Dordrecht: Springer.

Pfau, Roland, and Enoch O. Aboh. 2012. 'On the Syntax of Spatial Adpositions in Sign Languages'. In *Proceedings of IATL 27 (MIT Working Papers in Linguistics, 68)*, edited by Evan Cohen, and Avi Mizrachi, 83–104.

Pfau, Roland, and Susanne Glück. 2000. 'The Pseudo-simultaneous Nature of Complex Verb Forms in German Sign Language'. In *Proceedings of the 28th Western Conference on Linguistics*, edited by Nancy Mae Antrim, Grant Goodall, Martha Schulte-Nafeh and Vida Samiian, 428–442.

Pfau, Roland, Martin Salzmann and Markus Steinbach. 2018. 'The Syntax of Sign Language Agreement: Common Ingredients, but Unusual Recipe'. *Glossa: A Journal of General Linguistics*, 3 (1): 107, 1–46. DOI: 10.5334/gigl.511.

Pfau, Roland, and Markus Steinbach. 2003. 'Optimal Reciprocals in German Sign Language'. *Sign Language & Linguistics*, 6(1): 3–42.

Pfau, Roland, and Markus Steinbach. 2005a. 'Backward and Sideward Reduplication in German Sign Language'. In *Studies on Reduplication*, edited by Bernhard Hurch, 569–594. Berlin: Mouton de Gruyter.

Pfau, Roland, and Markus Steinbach. 2005b. 'Plural Formation in German Sign Language: Constraints and Strategies'. In *Gebärdensprachen: Struktur, Erwerb, Verwendung*, edited by Helen Leuninger, and Daniela Happ, 111–144. Special issue of *Linguistische Berichte*.

Pfau, Roland, and Markus Steinbach. 2006. 'Pluralization in Sign and in Speech: A Cross-modal Typological Study'. *Linguistic Typology*, 10: 135–182.

Pfau, Roland, and Markus Steinbach. 2011. 'Grammaticalization in Sign Languages'. In *The Oxford Handbook of Grammaticalization*, edited by Heiko Narrog and Bernd Heine, 683–695. Oxford: Oxford University Press.

Pfau, Roland, and Markus Steinbach. 2013. 'PERSON Climbing Up a Tree (and Other Adventures in Sign Language Grammaticalization)'. *Sign Language & Linguistics*, 16 (2): 189–220.

Pfau, Roland, and Markus Steinbach. 2021. 'Number in Sign Languages'. In *The Oxford Handbook of Grammatical Number*, edited by Patricia Cabredo Hofherr and Jenny Doetjes, 644–660. Oxford: Oxford University Press.

Quer, Josep. 2012. 'Negation'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 316–339. Berlin: De Gruyter Mouton.

Riggle, Jason. 2006. 'Infixing Reduplication in Pima and Its Theoretical Consequences'. *Natural Language and Linguistic Theory*, 24: 857–891.

Rubino, Carl. 2005. 'Reduplication'. In *The World Atlas of Language Structures*, edited by Martin Haspelmath, Matthew S. Dryer, David Gil and Bernard Comrie, 114–117. Oxford: Oxford University Press.

Sandler, Wendy. 1989. *Phonological Representation of the Sign: Linearity and Nonlinearity in American Sign Language*. Dordrecht: Foris.

Sandler, Wendy. 1999. 'Cliticization and Prosodic Words in a Sign Language'. In *Studies on the Phonological Word*, edited by Tracy A. Hall and Ursula Kleinhenz, 223–254. Amsterdam: John Benjamins.

Sandler, Wendy. 2008. 'The Syllable in Sign Language: Considering the Other Natural Language Modality'. In *The Syllable in Speech Production*, edited by Barbara L. Davis and Krisztina Zajdó, 379–407. New York: Lawrence Erlbaum.

Sandler, Wendy. 2021. 'Signs and Words'. In *All Things Morphology: Its Interdependence and Its Interfaces*, edited by Sedigheh Moradi, Marcia Haag, Janie Rees-Miller and Andrija Petrovic, 57–80. Amsterdam: John Benjamins.

Santoro, Mirko. 2018. 'Compounds in Sign Languages: The Case of Italian and French Sign Language'. PhD diss., École des Hautes Études en Sciences Sociales (EHESS), Paris.

Sapountzaki, Galini. 2012. 'Agreement Auxiliaries'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 204–227. Berlin: De Gruyter Mouton.

Schembri, Adam. 2003. 'Rethinking "Classifiers" in Signed Languages'. In *Perspectives on Classifier Constructions in Sign Languages*, edited by Karen Emmorey, 3–34. Mahwah, NJ: Lawrence Erlbaum.

Schembri, Adam, Kearsy Cormier and Jordan Fenlon. 2018. 'Indicating Verbs as Typologically Unique Constructions: Reconsidering Verb "Agreement" in Sign Languages'. *Glossa: A Journal of General Linguistics*, 3 (1): 89, 1–40.

Schembri, Adam, Caroline Jones and Denis Burnham. 2005. 'Comparing Action Gestures and Classifier Verbs of Motion: Evidence from Australian Sign Language, Taiwan Sign Language, and Nonsigners' Gestures without Speech'. *Journal of Deaf Studies and Deaf Education*, 10 (3): 272–290.

Schlenker, Philippe. 2018. 'Visible Meaning: Sign Languages and the Foundations of Semantics'. *Theoretical Linguistics*, 44 (3/4): 123–208.

Schlenker, Philippe, Jonathan Lamberton and Mirko Santoro. 2013. 'Iconic Variables'. *Linguistics and Philosophy*, 36: 91–149.

Schuit, Joke. 2013. 'Typological Aspects of Inuit Sign Language'. PhD diss., University of Amsterdam.

Siddiqi, Daniel. 2010. 'Distributed Morphology'. *Language and Linguistics Compass*, 4 (7): 524–542.

Siewierska, Anna. 2005. ‘Verbal Person Marking’. In *The World Atlas of Language Structures*, edited by Martin Haspelmath, Matthew S. Dryer, David Gil and Bernard Comrie, 414–417. Oxford: Oxford University Press.

Steinbach, Markus. 2011. ‘What Do Agreement Auxiliaries Reveal about the Grammar of Sign Language Agreement?’ *Theoretical Linguistics*, 37: 209–221.

Steinbach, Markus. 2012. ‘Plurality’. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 112–136. Berlin: De Gruyter Mouton.

Steinbach, Markus. 2021. ‘Role Shift: Theoretical Perspectives’. In *Theoretical and Experimental Sign Language Research*, edited by Josep Quer, Roland Pfau and Annika Herrmann, 351–377. London: Routledge.

Steinbach, Markus. 2022. ‘Differential Object Marking in Sign Languages? Restrictions on (Object) Agreement in German Sign Language’. In *Angles of Object Agreement*, edited by Jana Willer-Gold and Andrew Nevins, 209–240. Oxford: Oxford University Press.

Steinbach, Markus, and Edgar Onea. 2016. ‘A DRT Analysis of Discourse Referents and Anaphora Resolution in Sign Language’. *Journal of Semantics*, 33: 409–448.

Steinbach, Markus, and Roland Pfau. 2007. ‘Grammaticalization of Auxiliaries in Sign Languages’. In *Visible Variation. Comparative Studies on Sign Language Structure*, edited by Pamela Perniss, Roland Pfau, and Markus Steinbach, 303–339. Berlin: Mouton de Gruyter.

Supalla, Ted. 1986. ‘The Classifier System in American Sign Language’. In *Noun Classes and Categorization*, edited by Colette Craig, 181–214. Amsterdam: John Benjamins.

Supalla, Ted, and Elissa L. Newport. 1978. ‘How Many Seats in a Chair? The Derivation of Nouns and Verbs in American Sign Language’. In *Understanding Language Through Sign Language Research*, edited by Patricia Siple, 91–132. New York: Academic Press.

Tang, Gladys, Jia Li and Jia He. 2021. ‘Classifiers: Theoretical Perspectives’. In *The Routledge Handbook of Theoretical and Experimental Sign Language Research*, edited by Josep Quer, Roland Pfau and Annika Herrmann, 139–173. Oxford: Routledge.

Tomaszewski, Piotr. 2015. ‘Constraints on Negative Prefixation in Polish Sign Language’. *PLoS ONE*, 10 (11): e0143574. DOI: 10.1371/journal.pone.0143574.

van Boven, Cindy. 2021. ‘Phonological Restrictions on Nominal Pluralization in Sign Language of the Netherlands: Evidence from Corpus and Elicited Data’. *Folia Linguistica*, 55 (2): 313–359. https://doi.org/10.1515/flin-2021-2039.

van Boven, Cindy, Silke Hamann and Roland Pfau. 2021. ‘Nominal Plurals in Sign Language of the Netherlands: Accounting for Patterns and Variation in Stochastic Optimality Theory’. Paper delivered at *Formal and Experimental Advances in Sign Language Theory (FEAST 9)*, Hong Kong, June 3, 2021.

van Loon, Esther, Roland Pfau and Markus Steinbach. 2014. ‘The Grammaticalization of Gestures in Sign Languages’. In *Body – Language – Communication: An International Handbook on Multimodality in Human Interaction*, edited by Cornelia Müller, Alan Cienki, Esther Fricke, Silva Ladewig, David McNeill and Sedinha Tessendorf, 2133–2149. Berlin: De Gruyter Mouton.

Vercellotti, Mary Lou, and David R. Mortensen. 2012. ‘A Classification of Compounds in American Sign Language: An Evaluation of the Bisetto and Scalise Framework’. *Morphology*, 22: 545–579. DOI: 10.1007/s11525-012-9205-1.

Wallin, L. 1996. ‘Polysynthetic Signs in Swedish Sign Language’. PhD diss., University of Stockholm.

Wilbur, Ronnie B. 2009. ‘Productive Reduplication in a Fundamentally Monosyllabic Language’. *Language Sciences*, 31: 325–342.

Wilcox, Sherman. 2004. ‘Gesture and Language: Cross-linguistic and Historical Data from Signed Languages’. *Gesture*, 4: 43–73.

Yip, Moira. 2002. *Tone*. Cambridge: Cambridge University Press.
Zeshan, Ulrike. 2004. 'Hand, Head, and Face: Negative Constructions in Sign Languages'. *Linguistic Typology*, 8: 1–58.
Zeshan, Ulrike, and Sibaji Panda. 2011. 'Reciprocal Constructions in Indo-Pakistani Sign Language'. In *Reciprocals and Semantic Typology*, edited by Nicholas Evans, Alice Gaby, Stephen C. Levinson and Asifa Majid, 91–113. Amsterdam: John Benjamins.
Zwitserlood, Inge 2003. 'Classifying Hand Configurations in Nederlandse Gebarentaal'. PhD diss., University of Utrecht.
Zwitserlood, Inge. 2012. 'Classifiers'. In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinbach and Bencie Woll, 158–186. Berlin: De Gruyter Mouton.
Zwitserlood, Inge, and Ingeborg van Gijn. 2006. 'Agreement Phenomena in Sign Language of the Netherlands.' In *Arguments and Agreement*, edited by Peter Ackema, Patrick Brandt, Maaike Schoorlemmer, and Fred Weerman, 195–229. Oxford: Oxford University Press.
Zwitserlood, Inge, Pamela Perniss and Aslı Özyürek. 2012. 'An Empirical Investigation of Expressions of Multiple Entities in Turkish Sign Language (TİD): Considering the Effects of Modality'. *Lingua*, 122: 1636–1667.