

Sign Language Semantics*

Philippe Schlenker^{1,2}, Jonathan Lamberton³ and Jeremy Kuhn¹

Draft, September 12, 2023

Abstract: We survey recent developments in the formal semantics of sign languages, with three foci: (i) potential (and debated) cases of 'Logical Visibility', in which sign might make overt some logico-grammatical categories that are usually covert in speech; (ii) the interaction between grammar and iconicity; (iii) the comparison between sign with iconicity and speech with gestures, and the existence of universal properties of the signed modality.

- 1. Logical Visibility I: Loci
 - 1.1 Loci as visible variables
 - 1.2 Time and world-denoting loci
 - 1.3 Degree-denoting loci
 - 1.4 Dynamic loci
- 2. Logical Visibility II: Beyond Loci
 - 2.1 Telicity
 - 2.2 Context shift
 - 2.3 Abstract pluralization operations
 - 2.4 Coordination: Logical non-visibility?
- 3. Iconicity I: Optional Iconic Modulations
 - 3.1 Iconic modulations
 - 3.2 Event structure
 - 3.3 Plurals and pluractionals
 - 3.4 Iconic loci and iconic mappings
- 4. Iconicity II: Classifier Predicates
 - 4.1 The demonstrative analysis of classifier predicates
 - 4.2 The pictorial analysis of classifier predicates
 - 4.3 Comparison
 - 4.4 Necessary refinements
- 5. Sign with Iconicity versus Speech with Gestures
 - 5.1 Reintegrating gestures in the sign/speech comparison
 - 5.2 Typology of iconic contributions in speech and in sign
 - 5.3 Classifier predicates and pro-speech gestures
- 6. Universal Properties of the Signed Modality
 - 6.1 Sign language typology and sign language emergence
 - 6.2 Sign language grammar and gestural grammar
 - 6.3 Why convergence?
- 7. Future Issues

* Schlenker and Kuhn wrote the article. Lamberton commented and provided some of the ASL data.

Funding: Schlenker, Lamberton, Kuhn: This research received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No 788077, Orisem, PI: Schlenker).

Schlenker, Kuhn: Research was conducted at DEC, Ecole Normale Supérieure - PSL Research University. DEC is supported by grant FrontCog ANR-17-EURE-0017.

¹ Institut Jean-Nicod (ENS - EHESS - CNRS), Paris, France; PSL Research University, Paris France

² New York University, New York, NY, USA

³ New York, NY, USA

- Bibliography

Sign languages (in the plural: there are many) arise naturally as soon as groups of deaf people have to communicate with each other. Sign languages became institutionally established starting in the late 18th century, when schools using sign languages were founded in France, and spread across different countries, gradually leading to a golden age of Deaf culture (we capitalize *Deaf* when talking about members of a cultural group, and use *deaf* for the audiological status). This came to a partial halt in 1880, when the Milan Congress declared that oral education was superior to sign language education (Lane 1989)—a view that is amply refuted by research (Napoli et al. 2015). While sign languages continued to be used in Deaf education in some countries (e.g. the United States), it was only in the 1970's that a Deaf Awakening gave renewed prominence to sign languages in the western world (see Lane 1989 for a broader history).

Besides their obvious and essential role in Deaf culture and education, sign languages have a key role to play for linguistics in general and for semantics in particular. Despite earlier misconceptions that denied them the status of full-fledged languages, their grammar, their expressive possibilities, and their brain implementation are overall strikingly similar to those of spoken languages (Sandler and Lillo-Martin 2006, MacSweeney et al. 2008). In other words, human language exists in two modalities, signed and spoken, and any general theory must account for both, a view that is accepted in phonology, morphology, syntax, semantics and pragmatics.

Cross-linguistic semantics is thus naturally concerned with sign languages. In addition, sign languages (or 'sign' for short) raise several foundational questions for the field. These include (a) cases of 'Logical Visibility', (b) cases of iconicity, and (c) the potential universal accessibility of certain properties of the sign modality.

Historically, a number of notable early works in sign language semantics have taken a similar argumentative form, proposing that certain key components of Logical Forms that are covert in speech sometimes have an overt reflex in sign ('Logical Visibility'). Such arguments have been formulated for a diverse set of phenomena, including logical variables associated with syntactic indices (Lillo-Martin and Klima 1990), context shift operators (Quer 2005, 2013), and verbal morphemes relevant to telicity (Wilbur 2003, 2008; Wilbur and Malaia 2008). The semantic import of these arguments is clear: if a logical element is indeed overtly realized, it has ramifications for the inventory of the logical vocabulary of human language, and indirectly for the types of entities that must be postulated in semantic models ('natural language ontology', Moltmann 2017). Moreover, when a given element has an overt reflex, one can directly manipulate it in order to investigate its interaction with other parts of the grammar.

Arguments based on Logical Visibility are certainly not unique to sign language (e.g. see for instance Matthewson 2001 and Cable 2011 for the importance of semantic fieldwork for spoken languages), nor do they entail that sign languages as a class will make visible the same set of logical elements. Nevertheless, a notable finding from cross-linguistic work on sign languages is that a number of the logical elements implicated in these discussions do indeed appear with a similar morphological expression across a large number of historically unrelated sign languages (e.g. see Wilbur 2008 and Malaia et al. 2013 for discussion of telicity). Such observations invite deeper speculation about what it is about the signed modality that makes certain logical elements likely to appear in a given form.

A second thread of semantically-relevant research relates to the observation that sign languages make rich use of iconicity (Liddell 2003; Taub, 2001; Cuxac and Sallandre 2007), the property by which a symbol resembles its denotation by preserving some its structural properties. These patterns of iconicity introduce a number of foundational questions. First, some of the same semantic elements that are implicated in arguments for Logical Visibility turn out to be employed and manipulated in the expression of concrete or abstract iconic relations (e.g. pictorial uses of individual-denoting expressions; scalar structure; mereological structure), thus suggesting that logical and iconic notions are intertwined at the core of sign language. Second, sign languages have designated conventional words whose position or movement must be interpreted iconically; the corresponding interpretation must incorporate information from both the conventional meaning of these items and the way they are produced, introducing questions related to debates surrounding quotation. Third, while

some instances of iconicity are diagrammatic, others involve the creation of rich picture-like representations, which might call for an integration of techniques from pictorial semantics into natural language semantics (Schlenker 2018a; Schlenker and Lamberton, to appear). Finally, this high degree of iconicity raises questions about the comparison between speech and sign, with the possibility that, along iconic dimensions, the latter is expressively richer (Goldin-Meadow and Brentari 2017; Schlenker 2018a).

Possibly due in part to the above factors, sign languages—even when historically unrelated—behave as a coherent language family, with several semantic properties in common that are not generally shared with spoken languages (Sandler and Lillo-Martin 2006). Furthermore, some of these properties seem to be 'known' by individuals that do not have access to sign language; these include hearing non-signers and also deaf homesigners (i.e. deaf individuals that are not in contact with a Deaf community and thus have to invent signs to communicate with their hearing environment; Coppola et al. 2013). This finding raises the possibility that in the visual modality, not just abstract rules are specified by Universal Grammar, but sometimes also the precise mapping between grammatical/logical functions and forms that express them; an alternative is that these properties are determined by deeper aspects of cognition that are not specifically linguistic in nature.

In the following, we leave aside important issues of information structure, which often involve facial articulators—for instance, raised eyebrows can serve to mark topic and focus, among others.

1. Logical Visibility I: Loci

In several cases of foundational interest, sign languages don't just have the same types of Logical Forms as spoken languages; they may make overt key parts of the logical vocabulary that are usually covert in spoken language. These have been called instances of 'Logical Visibility' (Schlenker 2018a; following the literature, we use the term 'logical' loosely, to refer to primitive distinctions that play a key role in a semantic analysis).

(1) Hypothesis: Logical Visibility

Sign languages can make overt parts of the logical/grammatical vocabulary which (i) have been posited in the analysis of the Logical Form of spoken language sentences, but (ii) are not morphologically realized in spoken languages.

Claims of logical visibility have been made for logical variables associated with syntactic indices (Lillo-Martin and Klima 1990; Schlenker 2018a), for context shift operators (Quer 2005, 2013; Schlenker 2018a), and for verbal morphemes relevant to telicity (Wilbur 2003, 2008; Wilbur and Malaia 2008). In each case, the claim of Logical Visibility has been debated, and many questions remain open.

In this section, we discuss cases in which logical variables of different types have been argued to sometimes be overt in sign—a claim that has consequences of foundational interest for semantics; we will discuss further potential cases of Logical Visibility in the next section.

In English and other languages, sentences such as (2)a and (3)a can be read in three ways, depending on whether the embedded pronoun is understood to depend on the subject, on the object, or to refer to some third person.

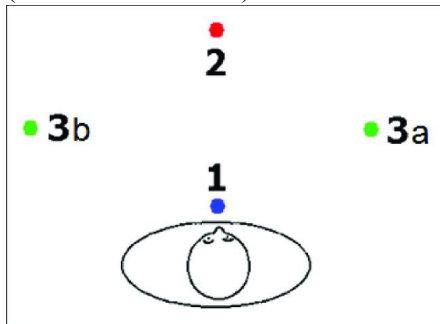
- (2) a. Sarkozy_i told Obama_k that he_{i/k/m} would be re-elected.
b. Sarkozy λi Obama λk t_i told t_k that he_{i/k/m} would be re-elected.
- (3) a. [A representative]_i told [a senator]_k that he_{i/k/m} would be re-elected.
b. [a representative]_i λi [a senator]_k λk t_i told t_k that he_{i/k/m} would be re-elected

A claim of Logical Visibility relative to variables has been made in sign because one can introduce a separate position in signing space or 'locus' (plural 'loci') for each of the antecedents (e.g. Sarkozy on the left and Obama on the right for (2)), and one can then point towards these loci (towards the left or towards the right) to realize the pronoun: loci thus mirror the role of variables in these examples.

1.1 Loci as visible variables?

Sign languages routinely use positions in signing space (loci) to represent objects or individuals one is talking about. Pronouns can be realized by pointing towards these positions. The signer and addressee are represented in a fixed position that corresponds to their real one, and similarly for third persons that are present in the discourse situation: one points at them to refer to them. But in addition, arbitrary positions can be created for third persons that are not present in the discourse. The maximum number of loci that can be simultaneously used seems to be determined by considerations of performance (e.g. memory) rather than by rigid grammatical conditions (there are constructed examples with up to 7 loci in the literature).

- (4) **Loci corresponding to the signer (1), the addressee (2), and different third persons (3a and 3b)**
(from Pfau et al. 2018)



We focus on the description of loci in American Sign Language (ASL) and French Sign Language (LSF, for 'Langue des Signes Française'), but these properties appear in a similar form across the large majority of sign languages. Singular pronouns are signed by directing the index finger towards a point in space; plural pronouns can be signed with a variety of strategies, including using the index finger to trace a semi-circle around an area of space, and are typically used to refer to groups of at least three entities. Other pronouns specify a precise number of participants with an incorporated numeral (e.g. dual, trial), and move between two or more points in space. In addition, some verbs (called 'agreement verbs') behave as if they contain a pronominal form in their realization, pertaining to the subject and/or to the object. For instance, *TELL* in ASL targets different positions depending on whether the object is second person (on the left below) or third person (on the right below).

- (5) **An object agreement verb in ASL**
I tell you



I tell him/her



Credits: ©Dr. Bill Vicars, <https://www.lifeprint.com/asl101/pages-signs/t/tell.htm>

Loci often make it possible to disambiguate pronominal reference. For instance, the ambiguity of the example in (2) can be removed in LSF, where the sentence comes in two versions. In both, Sarkozy is assigned a locus on the signer's left (by way of the index of the left hand held upright, 'b_{left}' below), and Obama a locus on the

right (using the index of the right hand held upright, 'b_{right}' below). The verb *tell* in *he (Sarkozy) tells him (Obama)* is realized as a single sign linking the Sarkozy locus on the left to the Obama locus on the right (unlike the ASL version, which just displays object agreement, the LSF version displays both subject and object agreement: 'leftTELL_{right}' indicates that the sign moves from the Sarkozy locus on the left to the Obama locus on the right). But now comes the crucial part: if *he* refers to Sarkozy, the signer points towards the Sarkozy locus on the left ('c_{left}'); if *he* refers to Obama, the signer points towards the Obama locus on the right ('c_{right}').

- (6) SARKOZY b_{left} OBAMA b_{right} leftTELL_{right}
'Sarkozy told Obama...'
- a. c_{left} WILL WIN ELECTION.
that he, Sarkozy, would win the election.'
- b. c_{right} WILL WIN ELECTION.
that he, Obama, would win the election.'

Video: <https://youtu.be/4u8GoVjvn4g>

In sign language linguistics, the convention is to transcribe signs in capital letters, as was the case above. In addition, loci are encoded by way of letters (*a*, *b*, *c*, ...), starting from the signer's dominant side (right for a right-handed signer, left for a left-handed signer). The upward fingers used to establish positions for Sarkozy and Obama are called 'classifiers' and are glossed here as *CL* (with the conventions of Section 4.2. the gloss would be *PERSON-cl*; classifiers are just one way to establish the position of antecedents, and they are not essential here). Pronouns involving pointing with the index finger are glossed as *IX*. With these conventions, the sentence in (6) can be represented with linguistic conventions as in (7). (When present in the original sources, we keep the references of the source videos, e.g. 'LSF 4, 235'.)

- (7) SARKOZY CL_b OBAMA CL_a b-TELL-a {IX-b / IX-a} WILL WIN ELECTION.
'Sarkozy told Obama that he, {Sarkozy/Obama}, would win the election.' (LSF 4, 235)

The ambiguity of quantified sentences such as the one in (3) can also be removed in sign, as illustrated in an LSF sentence in (8).

- (8) DEPUTY_b SENATOR_a CL_b-CL_a IX-b a-TELL-b {IX-a / IX-b} WIN ELECTION
'An MP_b told a senator_a that he_a / he_b (= the deputy) would win the election.' (LSF 4, 233)

In light of these data, the claim of Logical Visibility is that that sign language loci (when used—for they need not be) are an overt realization of logical variables.

One immediate objection that comes to mind is that pointing in sign might be very different from pronouns in speech. However this objection has little plausibility in view of multiple shared grammatical properties between pointing signs and spoken language pronouns. For example, pronouns in speech are known to follow grammatical constraints that determine which terms (e.g. *her* vs. *herself*) can be used in which environments; sign languages have been shown to be sensitive to the same kinds of rules, entering into an established typology of cross-linguistic variation (Kuhn 2021; Wilbur 1996; Koulidobrova 2011).

It is thus generally agreed that pronouns in sign are part of the same abstract system as pronouns in speech. It is also apparent that loci play a similar function to logical variables, disambiguating antecedents and tracking reference. This being said, the claim that loci are a direct morphological spell-out of logical variables requires a more systematic evaluation of the extent to which sign language loci have the formal properties of logical variables. As a concrete counterpoint, one observes that gender features in English *also* play a similar function, disambiguating antecedents and tracking reference. For instance, *Joe Biden told Kamala Harris that he would be elected* has a rather unambiguous reading (*he* = *Biden*), while *Joe Biden told Kamala Harris that she would be elected* has a different one (*she* = *Harris*). Such parallels have led some linguists to propose

that loci should best be viewed as grammatical features akin to gender features (Neidle et al. 2000; Kuhn 2016).

As it turns out, sign language loci seem to share some properties with logical variables, and some properties with grammatical features. On the one hand, the flexibility with which loci can be used seems closer to the nature of logical variables than to grammatical features. First, gender features are normally drawn from a finite inventory, whereas there seems to be no upper bound to the number of loci used except for reasons of performance. Second, gender features have a fixed form, whereas loci can be created 'on the fly' in various parts of signing space. On the other hand, loci may sometimes be disregarded in ways that resemble gender features. A large part of the debate has focused on sign language versions of sentences such as: *Only Ann did her homework*. This has a salient ('bound variable') reading that entails that *Bill didn't do his homework*. In order to derive this reading, linguists have proposed that the gender features of the pronoun *her* must be disregarded, possibly because they are the result of grammatical agreement. Loci can be disregarded in the very same kind of context, suggesting that they are features, not logical variables (Kuhn 2016). In light of this theoretical tension, a possible synthesis is that loci are a visible realization of logical variables, but mediated by a featural level (Schlenker 2018a). The debate continues to be relatively open.

While there has been much theoretical interest in cases in which reference is disambiguated by loci, this is usually an option, not an obligation. In ASL, for instance, it is often possible to realize pronouns by pointing towards a neutral locus that need not be introduced explicitly by nominal antecedents, and in fact several antecedents can be associated with this default locus. This gives rise to instances of referential ambiguity that are similar to those found in English in (3)-(4) above (see Frederiksen and Mayberry 2022; for an account that treats loci as corresponding to entire regions of signing space, and also allows for sign language pronouns without locus specification, see Steinbach and Onea 2016).

1.2 Time and world-denoting loci

Regardless of the precise analytical implementation, the flexible nature of sign language loci allows one to revisit foundational questions about anaphora and reference.

In the analysis of temporal and modal constructions in speech, there are two broad analytical directions. One goes back to quantified tense logic and modal logic, and takes the temporal and modal expressions of natural language to be fundamentally different from individual-denoting expressions: the latter involve the full power of individual-denoting variables and quantifiers, whereas no variables exist in the temporal and modal domain, although operators manipulate implicit parameters. The opposite view is that natural language has in essence the same logical vocabulary across the individual, the temporal and the modal domains, with variables (which may take different forms across different domains) and quantifiers that may bind them. This second tradition was forcefully articulated by Partee (1973) for tense and Stone (1997) for mood. Partee's and Stone's argument was in essence that tense and mood have virtually all the uses that pronouns do. This suggests, theory-neutrally, that pronouns, tenses and moods have a common semantic core. With the additional assumption that pronouns should be associated with variables, this suggests that tenses and moods should be associated with variables as well, perhaps with time- and world-denoting variables, or with a more general category of situation-denoting variables.

As an example, pronouns can have a deictic reading on which they refer to salient entities in the context; if a person sitting alone with their head in their hands utters: *She left me*, one will understand that *she* refers to the speaker's former partner. Partee argued that tense has deictic uses too. For instance, if an elderly author looks at a picture selected by their publisher for a forthcoming book and says: *I wasn't young*, one will understand that the author wasn't young *when the picture was taken*. Stone similarly argued that mood can have deictic readings, as in the case of someone who, while looking at a high-end stereo in an electronics store, says: *My neighbors would kill me*. The interpretation is that the speaker's neighbors would (metaphorically) kill them "if the speaker bought the stereo and played it a 'satisfying' volume", in Stone's words. A wide variety of other uses of pronouns can similarly be replicated with tense and mood, such as cross-sentential binding with indefinite antecedents. (In the individual domain: *A woman will go to Mars*.

She [=the woman who goes to Mars] will be famous. In the temporal domain: I sometimes go to China. I eat Peking duck [=in the situations in which I visit China, I eat Peking duck].)

While strong, these arguments are indirect because the *form* of tense and mood looks nothing like pronouns. In several sign languages, including at least ASL (Schlenker 2018a) and Chinese Sign Language (Lin et al. 2021), loci provide a more direct argument because in carefully constructed examples, pointing to loci can be used not just to refer to individuals, but also to refer to temporal and modal situations, with a meaning akin to that of the word *then* in English. It follows that the logical system underlying the ASL pronominal system (e.g. as variables) extends to temporal and modal situations.

A temporal example appears in (9): in the first sentence, *SOMETIMES WIN* is signed in a locus *a*. In the second sentence, the pointing sign *IX-a* refers back to the situations in which I win. The resulting meaning is that I am happy *in those situations in which I win*, not in general; this corresponds to the reading obtained with the word *then* in English: 'then I am happy'. (Here and below, 're' glosses raised eyebrows, with a line above the words over which eyebrow raising occurs.)

(9) Context: Every week I play in a lottery.

re
IX-1 [SOMETIMES WIN]_a. IX-a IX-1 HAPPY.
'Sometimes I win. Then I am happy.' (ASL 7, 202)

Formally, *SOMETIMES* can be seen as an existential quantifier over temporal situations, so the first sentence is semantically existential: *there are situations in which I win*. The pointing sign thus displays cross-sentential anaphora, depending on a temporal existential quantifier that appears in a preceding sentence. A further point made Chinese Sign Language (but not by the ASL example above) is that loci may be ordered on a temporal line, with the result that not just the loci but also their ordering can be made visible (Lin et al. 2021).

A similar argument can be made about anaphoric reference to modal situations: in (10), the second sentence just asserts that there are possible situations in which I am infected, associating the locus *a* with situations of infection. The second sentence makes reference to those such situations: in those situations (not in general), I have a problem. Here too, the reading obtained corresponds to a use of the word *then* in English.

(10) re
FLU SPREAD. IX-1 POSSIBLE INFECTED_a. IX-a IX-1 PROBLEM.
'There was a flu outbreak. I might get infected. Then I have a problem.' (ASL 7, 186)

In sum, temporal and modal loci make two points. First, theory-neutrally, the pointing sign can have both the use of English pronouns and of temporal and modal readings of the word *then*, suggesting that a single system of reference underlies individual, temporal and modal reference. Second, on the assumption that loci are the overt realization of some logical variables, sign languages provide a morphological argument for the existence of temporal and modal variables alongside individual variables.

1.3 Degree-denoting loci

In spoken language semantics, there is a related debate about the existence of degree-denoting variables. The English sentences *Ann is tall* and *Ann is taller than Bill* (as well as other gradable constructions) can be analyzed in terms of reference to degrees, for instance as in (11).

- (11) a. Ann is tall
 the maximal degree to which Ann is tall \geq the threshold for 'tall'
 b. Ann is taller than Bill
 the maximal degree to which Ann is tall \geq the maximal degree to which Bill is tall

To say that one *can* analyze the meaning in terms of reference to degrees doesn't entail that one must (for discussion, see Klein 1980). And even if one posits quantification over degrees, a further question is whether natural language has counterparts of pronouns that refer to degrees—if so, one would have a reasonable argument that natural language is committed to degrees.

Degree-denoting pronouns exist in some constructions of Italian Sign Language (LIS; Aristodemo 2017). In (12), the movement of the sign *TALL* ends at a particular location on the vertical axis (which we call α , to avoid confusion with the Latin characters used for individual loci in the horizontal plane), which intuitively represents Gianni's degree of height. In the second sentence, the pronoun points towards this degree-denoting locus, and the rest of the sentence characterizes this degree of height.

- (12) GIANNI TALL α . IX- α 1 METER 70
'Gianni is tall. His height is 1.70 meters.' (Aristodemo 2017, (2.23))

More complicated examples can be constructed in which *Ann is taller than Bill* makes available two degree-denoting loci, one corresponding to Ann's height and the other to Bill's.

In sum, some constructions of LIS provide evidence for the existence of degree-denoting pronouns in sign language, which in turn suggests that natural language is sometimes committed to the existence of degrees. And if one grants that loci are the realization of variables, one obtains the further conclusion that natural language has at least some degree-denoting variables. (It is a separate question whether all languages *avail* themselves of degree variables; see Beck et al. 2009 for the hypothesis that this is a parameter of semantic variation.)

Finally, we observe that, unlike the examples of individual-denoting pronouns seen so far, the placement of degree pronouns along a particular axis is semantically interpreted, reflecting the total ordering of their denotations. Intuitively, it thus seems that not only are degrees visibly realized, but so are the ordering relations that hold between them (cf. Section 1.3 regarding the similar ability to order temporal loci along a time line in Chinese Sign Language). We will return to such examples—as well as to examples involving individual and temporal variables—when we discuss issues of structural iconicity in Section 3.4.

1.4 Dynamic loci

In spoken language, quantifiers with existential force sometimes seem to bind variables that are not in their syntactic scope, as in the example mentioned above: *A woman will go to Mars. She will be famous*. Geach (1962) discussed the same problem within the confines of a single sentence, as in: *If a farmer owns a donkey, he beats it*. Similar cases arise in sign languages; indeed, we saw examples of the same form pertaining to reference to temporal and to modal situations in Section 1.2. Still, there have been considerable debates about the correct analysis of such cases, and sign language loci have provided new insights.

According to Dynamic Semantics, the logical syntax underlying natural languages is different from that of standard logic. Dynamic semantics develops rules that make it possible for a variable or a pronoun to depend on an existential quantifier or an indefinite without being within its scope.

According to E-type analyses, no new logical syntax is needed for natural language because the assimilation of pronouns to variables is incorrect. On this view, the pronoun *she* in the above discourse (*A woman will go to Mars. She will be famous*) is in fact a concealed description such as *the woman*, or *the woman who will go to Mars* (e.g. Evans 1980; Heim 1990; Elbourne 2005). Analyses that make this assumption are called 'E-type'.

E-type theories encounter an independent problem, pertaining to the existence of *formal link* between the pronoun and its antecedent. Despite the near-synonymy between the *if*-clauses in (13)a and (13)b, only the first licenses anaphora. Elbourne (2005) develops a particularly elegant version of the E-type theory which

solves this problem; for him, the descriptive content of an E-type pronoun is literally obtained by a process of nominal ellipsis. The contrast between (13)a and (13)b arises simply because the missing nominal can be found in *a wife* but not in *married*, as sketched in (13)c.

- (13) a. If Maurice Ravel had had a wife, she would have enjoyed his music.
 b. ??If Marice Ravel had been married, she would have enjoyed his music.
 c. If Maurice Ravel had had a wife, she ~~wife~~ would have enjoyed his music.

A natural assumption one could make about sign language is that this formal link is instantiated by locus assignment: a pointing sign towards a locus introduced by a certain nominal recovers the latter by way of ellipsis resolution.

This hypothesis, however, runs into problems involving so called 'bishop' sentences (so named because original examples involved bishops). In these sentences, two potential antecedents are described with exactly symmetric semantic properties, as in (14)a ((14)b makes the same point in a case in which, in addition, the two antecedents bear the same thematic role). On the E-type theory for sign language described above, the only contribution of pointing to a locus is to identify the NP material of the elided definite description. Counterintuitively, a version of this theory predicts that pointing to the locus corresponding to one individual can retrieve an individual corresponding to different locus *as long as the two were described symmetrically*. An equally counterintuitive corollary is the prediction that pointing to the same locus twice in these cases should allow an interpretation where the two pronouns receive different meanings. But this is not possible: pointing twice to the same locus (twice to *IX-a* or twice to *IX-b*) yields the wrong reading, one on which a given Frenchman wonders who he himself lives with.

- (14) a. WHEN [FRENCH MAN]_a a,b-MEET [FRENCH MAN]_b, IX-a WONDER WHO IX-b LIVE WITH.
 'When a Frenchman meets a Frenchman, the former wonders who the latter lives with.'
 (ASL, i P1040945)
 b. WHEN SOMEONE_a AND SOMEONE_b LIVE TOGETHER, IX-a LOVE IX-b.
 'When someone and someone live together, the former loves the latter.'
 (ASL, P1040966)

Stepping back, while the sign language data do not fully decide the debate between dynamic analyses and E-type analyses, they arguably favor the former, as they provide overt motivation for its main ingredients. In these examples, a sign language locus appears to play very much the role of a variable, which is carried by a pronoun and by the antecedent it is anaphoric to. The connection between a pronoun and its antecedent as instantiated by loci is not constrained by c-command, a key claim of dynamic semantics. And this relation has a semantic reflex, in the sense that different denotations are obtained for a pronoun depending on which locus or variable it is associated with.

2. Logical Visibility II: Beyond Loci

There are further cases in which sign language arguably makes visible some components of Logical Forms that are not always overt in spoken language.

2.1 Telicity

Semanticists traditionally classify event descriptions as *telic* if they apply to events that have a natural endpoint determined by that description, and they call them *atelic* otherwise. *Ann arrived* and *Mary understood* have such a natural endpoint, e.g. the point at which Ann reached her destination, and that at which Mary saw the light, so to speak: *arrive* and *understand* are telic. By contrast, *Ann waited* and *Mary reflected* lack such natural endpoints: *wait* and *reflect* are atelic. As a standard test (e.g. Rothstein 2004), a temporal modifier of the form *in α time* modifies telic VPs while *for α time* modifies atelic VPs (e.g. *Ann*

arrived in five minutes vs. *Ann waited for five minutes*, *Mary understood in a second* vs. *Mary reflected for a second*).

Telicity is a property of predicates (i.e., verbs complete with arguments and modifiers), not of verbs themselves. Whether a predicate is telic or atelic may thus result from a variety of different factors; these include adverbial modifiers that explicitly identify an endpoint—*run 10 kilometers (in an hour)* is telic, but *run back and forth (for an hour)* is atelic—and properties of the nominal arguments—*eat an apple (in two minutes)* is telic but *eat lentil soup (for two minutes)* is atelic. But telicity also depends on properties of the lexical semantics of the verb itself, as illustrated by the intransitive verbs above, as well as transitive examples like *found a solution (in an hour)* versus *look for a solution (for an hour)*. In work on spoken language, some theorists have posited that these lexical factors can be explained by a morphological decomposition of the verb, and that inherently telic verbs like *arrive* or *find* include a morpheme, 'Res', that specifies the endstate resulting from a process (Ramchand 2008).

In influential work, Wilbur (2003, 2008; Wilbur and Malaia 2008) has argued that the lexical factors related to telicity are often realized overtly in the phonology of several sign languages: inherently telic verbs tend to be realized with sharp sign boundaries; inherently atelic verbs are realized without them (Wilbur 2003, 2008; Wilbur and Malaia 2008). For instance, the ASL sign *ARRIVE* involves a sharp deceleration, as one hand makes contact with the other, as shown in (15).

(15) ARRIVE in ASL (telic)



<https://www.signingsavvy.com/sign/ARRIVE/12/1>

Picture credits: Valli, Clayton: 2005, *The Gallaudet Dictionary of American Sign Language*, Gallaudet University Press.

In contrast, *WAIT* is realized with a trilled movement of the fingers and optional circular movement of the hands, without a sharp boundary:

(16) WAIT in ASL (atelic)



<https://www.signingsavvy.com/sign/wait/463/4>

Picture credits: Valli, Clayton: 2005, *The Gallaudet Dictionary of American Sign Language*, Gallaudet University Press.

Similarly, in LSF *UNDERSTAND*, which is telic, is realized with three fingers forming a tripod that ends up closing on the forehead; the closure is realized quickly, and thus displays a sharp boundary. By contrast, *REFLECT*, which is atelic, is realized by the repeated movement of the curved index finger towards the temple, without sharp boundaries.

(17) a. UNDERSTAND (LSF)

b. REFLECT (LSF)



https://www.elix-lsf.fr/spip.php?page=signes&id_article=146439&lang=fr

https://www.elix-lsf.fr/spip.php?page=signes&id_article=206984&lang=fr

Credits: *La langue des signes - dictionnaire bilingue LSF-français*. IVT 1986

Wilbur (2008) posits that in ASL and other sign languages, this phonological cue, the "rapid deceleration of the movement to a complete stop", is an overt manifestation of the morpheme Res (also called EndState), yielding inherently telic lexical predicates. If Wilbur's analysis is correct, this is another possible instance of visibility an abstract component of Logical Forms that is not usually overt in spoken languages. An alternative is that an abstract version of iconicity is responsible for this observation (Kuhn 2015), as we will see in Section 3.2.

It is also possible that the analysis of this phonological cue varies across languages. Of note, both ASL and LSF have exceptions to the generalization (Davidson et al. 2019), for example ASL *SLEEP* is atelic but ends

with deceleration and contact between the fingers; LSF *RESIDE* is similarly atelic but ends with deceleration and contact. In contrast, in Croatian Sign Language (HZJ), endmarking appears to be a regular morphological process, allowing a verb stem to alternate between an end-marked and non-endmarked form (Milković 2011).

2.2 Context shift

An operator of 'context shift' has been argued to exist in several spoken languages (including Amharic and Zazaki), accounting for the fact that some indexicals can be shifted in the scope of some attitude verbs, and in the absence of quotation (e.g. Anand and Nevins 2004; Anand 2006; Deal 2020). Schematically, in such languages, *Ann says that I am a hero* can mean that Ann says that she herself is a hero, with *I* interpreted from Ann's perspective. Several researchers have argued that context shift can be overt in sign language, and realized by an operation called 'Role Shift', whereby the signer rotates her body to adopt the perspective of another character (Quer 2005, 2013; Schlenker 2018a).

A simple example involves the sentence *WIFE SAY IX-2 FINE*, where the boldfaced words are signed from the rotated position, illustrated below. As a result, the rest of the sentence is interpreted from the wife's perspective, with the consequence that the second person pronoun *IX-2* refers to whoever the wife is talking to, and not the addressee of the signer.

(18) An example of Role Shift in ASL



WIFE

SAY

IX-2

FINE

Credits: Lillo-Martin, Diane: 2012, Utterance Reports and Constructed Action. In R. Pfau, M. Steinbach and B. Woll (eds.), *Sign language – An international handbook*, 365–387. Sign Linguistics & Language Acquisition Lab, University of Connecticut.

Role Shift exists in several languages, and in some cases (notably in Catalan and German sign languages Quer 2005; Herrmann and Steinbach 2012), it has been argued not to involve mere quotation (in ASL and LSF, Role Shift has, at a minimum, a strong quotational component, as for instance angry facial expressions under Role Shift must be attributed to the attitude holder, not to the signer (Schlenker 2018a). On the context-shifting analysis of Role Shift (e.g. Quer 2005, 2013), the point at which the signer rotates her body corresponds to the insertion of a context-shifting operator *C*, yielding the representation: *WIFE SAY C [IX-2 FINE]*. The boldfaced words are signed in rotated position and are taken to be interpreted in the scope of *C*.

Interestingly, Role Shift differs from context-shifting operations described in speech in that it can be used outside of attitude reports (to distinguish the two cases, researchers use the term 'Attitude Role Shift' for the case we discussed before, and 'Action Role Shift' for the non-attitudinal case).

For example, if one is talking about an angry man who has been established at locus *a*, one can use an English-strategy and say *IX-a WALK-AWAY* to mean that he walked away. But an alternative possibility is to apply Role Shift after the initial pointing sign, and say the following (with the operator *C* realized by the signer's rotation):

(19) IX-a C [1-WALK-AWAY].

Here *I-WALK-AWAY* is a first person version of 'walk away', but the overall meaning is just that the angry person associated with locus *a* walked away. By performing a body shift and adopting that person's position to sign *I-WALK-AWAY*, the signer arguably makes the description more vivid. Importantly, in ASL and LSF, there are iconic effects as well: disgusted facial expressions under Action Role Shift are attributed to the agent rather than to the signer.

As in other cases of purported Logical Visibility, the claim that Role Shift is the visible reflex of an operation that is covert in speech has been challenged. In the analysis of Davidson (2015, following Supalla 1982), Role Shift falls under the category of classifier predicates, specific constructions of sign language that have a strong iconic component (we discuss them in Section 4). On this analysis, what is special about Role Shift is that the classifier is not signed with a hand (as other classifiers are), but rather with the signer's own body. Its iconic component displays aspects of the very words that appear in role-shifted position. For Attitude Role Shift, the analysis essentially derives a quotational reading via a demonstration—for our example above, something like: *My wife said this, "You are fine"*. Cases of Attitude Role Shift that have been argued not to involve standard quotation (notably in Catalan and German sign language) require refinements of the analysis. For Action Role Shift, the operation has the effect of demonstrating those parts of signs that are not conventional, yielding in essence: *He walked away like this*, where *this* refers to all iconically interpretable components of the role-shifted construction (including the signer's angry expression, if applicable).

2.3 Abstract pluralization operations

While it is standard to posit widespread similarities between the mereological structure of objects and events, nominal and verbal expressions sometimes look very different. But in sign language, plural formation in the two domains ('plurals' for nouns (Pfau and Steinbach 2006), 'pluractionals' for verbs (Kuhn and Aristodemo 2017)) is often realized by one and the same operation, namely repetition.

Repetition-based plurals and pluractionals exist in speech (Sapir 1921, p. 79), but in sign they come with interesting peculiarities. So-called 'punctuated' repetitions (with clear breaks between the iterations) refer to precise plural quantities (e.g. three objects or events for three iterations), while 'unpunctuated' repetitions (without clear breaks between the iterations) refer to plural quantities with vague thresholds, and often 'at least' readings (Coppola et al. 2013; Pfau and Steinbach 2006; Schlenker and Lamberton 2022). While repetition could be viewed as an instance of an abstract pluralization morpheme that applies across ontological categories, an alternative view is that in this area sign language exploits a combination of iconicity and vagueness-based semantics (see Section 4).

2.4 Coordination: Logical non-visibility?

The examples above provide cases where logical elements that are not morphologically expressed in spoken languages appear in an overt form in sign languages. But can the reverse also be found? That is, are there logical elements that are typically expressed (i.e. visible) in spoken languages that remain covert in sign languages? And if so, can such examples be informative for natural language semantics?

Arguably, one such example is the case of coordination (conjunction and disjunction) in ASL (Davidson 2013). In ASL, there do exist lexical items *AND* and *OR*, but the two are used less frequently than in English. Both conjunction and disjunction are frequently realized using general use coordination strategies, expressed by concatenating constituents while enumerating on the fingers or shifting the body in space. For instance, the sentence in (20), in which *COORD-SHIFT* is pronounced by a shift in body position, can be interpreted as either (20)a or (20)b.

- (20) IX-a DRINK TEA-b COORD-SHIFT COFFEE-c.
a. 'She drank coffee and tea.'

b. 'She drank coffee or tea.'
(Davidson 2013)

Davidson (2013) makes the case that these sentences are genuinely ambiguous, but that the ambiguity does not arise from lexical ambiguity of *COORD-SHIFT*. She thus proposes that *COORD-SHIFT* collects its arguments as a set of (Hamblin-style) alternatives, and that quantification (universal or existential) is contributed by a silent higher operator. Similar examples in spoken languages (e.g. Japanese, Ohori 2004) suggest that conjunction and disjunction may in general be decomposable into two components: one which collects coordinates and one that quantifies over them.

While more work is needed to establish patterns of coordination in sign languages beyond ASL, it is possible that similar patterns appear frequently in the signed modality. Such a finding would be compatible with the observation that sign languages generally have fewer sequentially-expressed morphemes (but just as much propositional information!), due to a relatively slower articulatory speed of the hands compared to the mouth and tongue (Bellugi and Fischer 1972).

3. Iconicity I: Optional Iconic Modulations




We turn to constructions that display optional or obligatory iconicity in sign language. As we will see, some purported cases of Logical Visibility might be better analyzed as more or less abstract versions of iconicity, with the result that several phenomena discussed above can be analyzed from at least two theoretical perspectives.

By iconicity, we mean a rule-governed way in which an expression denotes something by virtue of its resemblance to it. We exclude from consideration lexicalized cases that may not result from a productive rule (as is for instance the case of the English noun *boom*, which refers to explosions). While iconicity in our sense exists in speech, it is probably more common and more diverse in sign, and sometimes raises special theoretical issues.

3.1 Iconic modulations

As in spoken language, it is possible to modulate some conventional words in an iconic fashion. In English, *the talk was looong* suggests that the talk wasn't just long but *very* long. Similarly, the conventional verb *GROW* in ASL can be realized more quickly to evoke a faster growth, and with broader endpoints to suggest a larger growth, as is illustrated below (Schlenker 2018b).

(21) Different iconic modulations of the sign *GROW* in ASL

	Narrow endpoints	Medium endpoints	Broad endpoints
			
Slow movement	small amount, slowly	medium amount, slowly	large amount, slowly
Fast movement	small amount, quickly	medium amount, quickly	large amount, quickly

Credits: M. Bonnet (for the figures)

There are multiple potential levels of speed and endpoint breadth, which suggests that a rule is genuinely at work in this case.

In English, iconic modulations can arguably be at-issue and thus interpreted in the scope of grammatical operators. An example is the following sentence: *If the talk is loooong, I'll leave before the end.* This means that if the talk is very long, I'll leave before the end (but if it's only moderately long, maybe not); here, the iconic contribution is interpreted in the scope of the *if*-clause, just like normal at-issue contributions. The iconic modulation of *GROW* has similarly been argued to be at-issue (Schlenker 2018b). (See Section 5.2 for further discussion on the at-issue vs. non-at-issue semantic contributions.)

While conceptually similar to iconic modulations in English, the sign language versions are arguably richer and more pervasive than their spoken language counterparts.

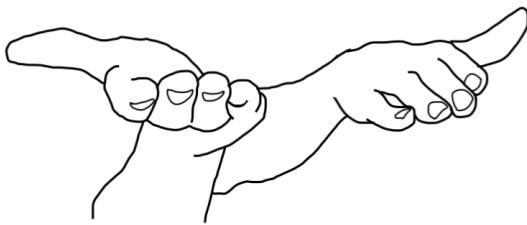
3.2 Event structure

Iconic modulation interacts with the marking of telicity noticed by Wilbur (Section 2.1). *GROW*, discussed in the preceding sub-section, is an (atelic) degree achievement; the iconic modifications above indicate the final degree reached and the time it took to reach that degree. Similarly, for telic verbs, the speed and manner in which the phonological movement reaches its endpoint can indicate the speed and manner in which the result state is reached. For example, if LSF *UNDERSTAND* is realized slowly and then quickly, the resulting meaning is that there was a difficult beginning, and then an easier conclusion. Atelic verbs that don't involve degrees can also be iconically modulated; for instance, if LSF *REFLECT* is signed slowly and then quickly, the resulting meaning is that the person reflected slowly at the beginning, and then more quickly. Here too, the iconic contribution has been argued to be at-issue (Schlenker 2018b).

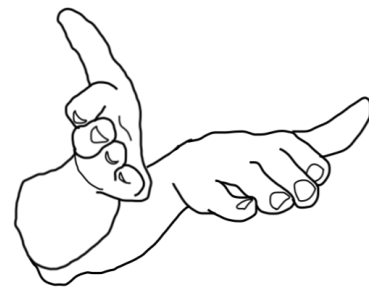
There are also cases in which the event structure is not just modulated but radically altered, as in the case of incomplete forms (also called unrealized inceptive, Liddell 1984; Wilbur 2008). ASL *DIE*, a telic verb, is expressed by turning the dominant hand palm-down to palm-up as shown below (the non-dominant hand turns palm-up to palm-down). If the hands only turn partially, the sign is roughly interpreted as 'almost die'.

(22) Normal vs. incomplete form of *DIE* in ASL

a. *DIE* in ASL (Kuhn 2015)



b. *ALMOST-DIE* in ASL (Kuhn 2015)



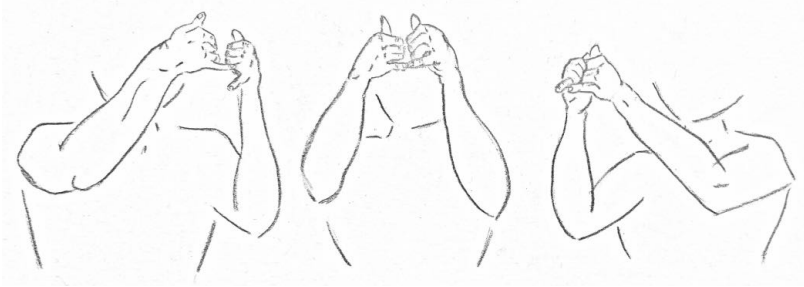
Similarly to the fact that multiple levels of speed and size can be indicated by the verb *GROW* in (21), the incomplete form of verbs can be modulated to indicate arbitrarily many degrees of completion, depending on how far the hand travels; these examples thus seem to necessitate an iconic rule (Kuhn 2015). On the other hand, while the examples with *GROW* can be analyzed by simple predicate modification ('The group grew and it happened like this: slowly'), examples of incomplete modification require a deeper integration in the semantics, similar to the semantic analysis of the adverb *almost* or the progressive aspect in English. (Notably, it's nonsense to say: 'My grandmother died and it happened like this: incompletely'.')

The key theoretical question is whether one needs a decompositional analysis with a covert morpheme, as in Wilbur's analysis (with the affix *Res*, see Section 2.1), and *in addition* an iconic component, or whether a structural form of iconicity is all one needs. An iconic analysis has been proposed (Kuhn 2015, Section 6.5), although a full account has yet to be developed.

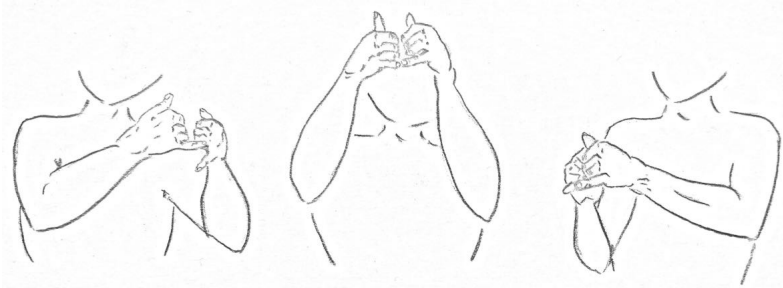
3.3 Plurals and pluractionals

Plural-based repetitions can also be modulated iconically: the number of repetitions provides an indication of the number of objects, and the arrangement of the repetitions in signing space can provide a pictorial representation of the arrangement of the denotations in real space (Schlenker and Lamberton 2022). For instance, the word *TROPHY* can be iterated three times on a straight line to refer to a group of trophies that are horizontally arranged; or the three iterations can be arranged as a triangle to refer to trophies arranged in a triangular fashion. A larger number of iterations serves to refer to larger groups. Here too, the iconic contribution can be at-issue and thus be interpreted in the scope of logical operators such as *if*-clauses.

(23) *TROPHY* in ASL, repetition on a line:



TROPHY in ASL, repetition as a triangle:



Credits: M. Bonnet

In addition, the iterations can be produced as 'punctuated' and thus easy to count, yielding meanings with precise thresholds (often with an 'exactly' reading, e.g. 'exactly three trophies' for three punctuated iterations); or they can be produced as 'unpunctuated', i.e. without clear breaks between them and thus hard to count, yielding vague thresholds and often 'at least' readings (e.g. 'several trophies' for three unpunctuated iterations). While one may take the distinction between punctuated and unpunctuated repetitions to be conventional, it might have an iconic source. In essence, unpunctuated iterations result in a kind of pictorial vagueness on which the threshold is hard to discern; deriving the full range of 'exactly' and 'at least' readings is non-trivial, however (Schlenker and Lamberton 2022).

In the verbal domain, pluractionals (referring to a plurality of events) can be created by repeating a verb, for instance in LSF and ASL. A complete analysis of these forms seems to require both conventionalized grammatical components and iconic components. On the one side, the form of reduplication—as identical reduplication or as alternating two-handed reduplication—appears to conventionally communicate the distribution of events with respect to either time or to participants. At the same time, a productive iconic rule appears to be involved, as the number and speed of the repetitions gives an idea of the number and speed of the denoted events (Kuhn and Aristodemo 2017); again, the iconic contribution can be at-issue.

Iconic plurals and pluractionals alike are now treated by way of mixed lexical entries that include a grammatical/logical component and an iconic component. For instance, if N is a (singular) noun denoting a set of entities S , then the iconic plural $N\text{-rep}$ denotes the set of entities x such that:

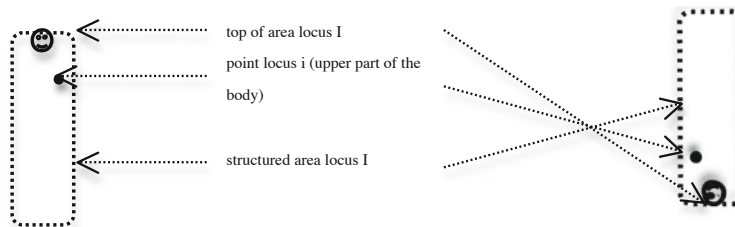
- (i) x is the sum of atomic elements in S (i.e., $x \in *S$), and
- (ii) the form of $N\text{-rep}$ iconically represents x .

Condition (i) is the standard definition of a plural; condition (ii) is the iconic part, which is itself in need of an elucidation using general tools of pictorial semantics (see Section 4).

3.4 Iconic loci and iconic mappings

Loci, which have been hypothesized to be (sometimes) the overt realization of variables, can lead a dual life as iconic representations. Singular loci may (but need not) be simplified pictures of their denotations: if so, an individual-denoting locus is a structured area I , and one points towards a point i that corresponds to the upper part of the body, as represented on the left for a person in upright position. In ASL, when the person is tall, one can point upwards, because this corresponds to the position of the upper part of their body (there are also less literal cases in which one points upwards because the person is powerful or important). For a person in an upside down position, the positions are reversed and one points downwards instead, as seen on the right below (Schlenker 2018a; see also Liddell 2003). There are additional possibilities when one discusses individuals that are rotated in various positions.

- (24) An iconic locus schematically representing a person in upright position (left) or in upside down position (right)

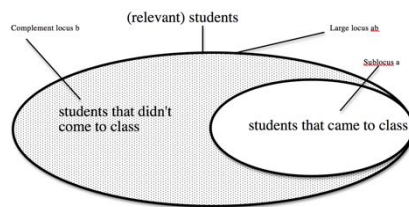


Iconic mappings involving loci may also preserve the abstract structural relations that have been posited to exist for various kinds of ontological objects. First, two plural loci may (but need not) be used diagrammatically, with a locus a embedded in b if the denotation of a is a mereological part of the denotation of b (Schlenker 2018a). Plural pronouns can thus point towards entire (broadly circular) areas of space.

The evidence for diagrammatic uses of plural loci comes from examples such as (25). The ASL expression *POSS-I STUDENT* ('my students') introduces a large locus glossed as ab (to make it clear that it contains subloci a and b —but initially it is just a large locus). *MOST* introduces a sublocus a within ab . And critically, when a plural pronoun points towards b —namely the complement of the sublocus a within the large locus ab —the sentence is acceptable, and b is understood to refer to the students who did *not* come to class.

- (25) POSS-1 STUDENT IX-arc-ab MOST IX-arc-a a-COME CLASS. IX-arc-b b-STAY HOME.
'Most of my students came to class. They stayed home.'
(ASL, 8, 196; Schlenker et al. 2013)

(26)



The availability of this reading is specifically due to diagrammatic reasoning. In English, the plural *they* clearly lacks such a reading when one says, *Most of my students came to class. They stayed home*. As a result, the discourse sounds contradictory. To obtain the target reading, one has to say, *The others stayed home*, but unlike the case of ASL, *the others* is not a pronoun at all. The English facts are replicated in ASL when one uses several occurrences of a default (non-localized) plural pronoun. This pronoun can refer, as its English counterpart, to the students that came to class, or to the entire set of students, but not to the students that didn't come to class. In other words, the reading obtained in (25) is specifically due to the diagrammatic use of loci.

A second case of preservation of abstract orders pertains to degree-denoting and sometimes time-denoting loci. In LIS, degree-denoting loci are represented iconically, with the total ordering mapped to an axis in space. Time-denoting loci may but need not give rise to preservation of ordering on an axis, depending on whether normal signing space is used (as in the ASL examples (9) above), or a specific timeline, as mentioned in Section 1.2 in relation to Chinese Sign Language (there are differences across sign languages in the position of the axes, and the ability to use pronouns (pointing) to refer to moments on that line (Aristodemo 2017; Lin et al. 2021)).

A third case involves the partial ordering of domain restrictions of nominal quantifiers. Greater height in signing space may be mapped to a larger domain of quantification, as is the case in ASL (Davidson 2015) and at least indefinite pronouns in Catalan Sign Language (Barberà 2015).

4. Iconicity II: Classifier Predicates

4.1 The demonstrative analysis of classifier predicates

A special construction, classifier predicates (or 'classifiers' for short), has raised difficult conceptual questions. While the form of classifiers is conventional and largely arbitrary (e.g. the ASL 'three' handshape, depicted below, represents a vehicle), their position, orientation and movement in signing space is interpreted iconically and gradiently (Emmorey and Herzig 2003), as illustrated below.

- (27) CAR CL-vehicle-DRIVE-BY. (ASL, Valli and Lucas 2000)



'A car drove by [with a movement resembling that of the hand]

Early analyses within formal semantics, notably by Zucchi and Davidson (Zucchi 2009; Davidson 2015),

took these constructions to have a self-referential demonstrative component, with the result that the moving vehicle classifier in (27) means in essence 'move like this', where 'this' makes reference to the very form of the classifier movement. In Zucchi's words (Zucchi 2017), "the intuitive idea behind these proposals is that movement in classifier predicates of motion is a gesture which fixes the referent of a hidden demonstrative (i.e., a demonstration), in the same way in which the reference of [a] demonstrative may be fixed by a gesture: *The car moved in a way similar to this.*" As mentioned in Section 2.2, this analysis was extended to Role Shift by Davidson (Davidson 2015), who took the classifier to be in this case the signer's rotated body.

4.2 The pictorial analysis of classifier predicates

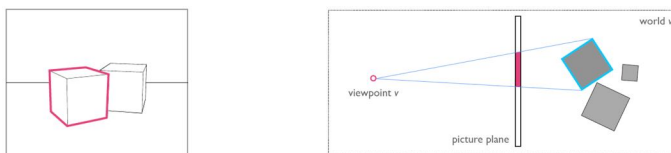
The demonstrative analysis of classifier predicates as stated has two general drawbacks. First, the analysis establishes a natural class containing classifiers and demonstratives (like English *this*), but the two phenomena possibly display different behaviors. Notably, while demonstratives behave roughly like free variables that can pick up their referent from any of a number of contextual sources, the iconic component of classifiers can only refer to the movement and configuration of the hand (any demonstrative variable is thus immediately saturated). Second, the demonstrative analysis currently relegates the iconic component to a black box. Without any interpretive principles on what it means for an event to be 'like' the demonstrated representation, one cannot provide any truth conditions for the sentence as a whole.

Any complete analysis must thus develop an explicit semantics for the iconic component. This is more generally necessary to derive explicit truth conditions from other iconic constructions in sign language, such as the repetition-based plurals discussed in Section 3.3. above: in the metalanguage, the condition [*a certain expression*] *iconically represents* [*a certain object*] was in need of explication.

A recent model has been offered by formal pictorial semantics, developed by Greenberg and Abusch (e.g. Greenberg 2013, 2021; Abusch 2020). The basic idea is that a picture obtained by a given projection rule (for instance, perspective projection) is true of precisely those situations that can project onto the picture. Greenberg (2014) has further extended this analysis with the notion of an object projecting onto a picture part (in addition to a situation projecting onto a whole picture). Reference to object by picture parts proves useful for sign language applications because they usually involve very partial iconic representation, with one iconic element representing a single object or event in a larger situation.

Such a system thus provides a mechanism to describe the truth conditions of a pictorial representation as a whole, as well as to identify the component entities represented within it. An example of Greenberg's analysis appears in (28), where the picture on the left is true of the situation on the right, and where the left-most shape in the picture in a. denotes the top cube in the situation in b.

- (28) The picture in a. is true of the situation in b., and the left-most shape in a. denotes the top cube in b.
a. Picture b. World



The full account makes reference to a notion of viewpoint relative to which perspective projection is assessed, and a picture plane, both represented in b. This makes it possible to say that the top cube (*top_cube*) projects onto the left-hand shape (*left_shape*) relative to the viewpoint (call it π), at the time t and in the world w in which the projection is assessed. In brief: $\text{proj}(\text{top_cube}, \pi, t, w) = \text{left_shape}$.

Explicit accounts of classifier predicates (as well as other iconic constructions, such as repetition-based plurals) make use a version of pictorial semantics to explicate the truth-conditional contribution of iconic elements.

A minimal pair will help bring out the iconic contribution of classifier predicates. There are two minimally different words for *airplane* in ASL: one is a normal noun, glossed as *PLANE*, and the other is a classifier predicate, glossed below as *PLANE-cl*. Both forms involve the handshape in , but the normal noun includes a tiny repetition (different from that of plurals) which is characteristic of some nominals in ASL.

- (29) Handshape for ASL *PLANE* (= nominal version) and for ASL *PLANE-cl* (= classifier predicate version)



One can posit the following lexical entries for the normal noun and for its classifier predicate version. Importantly, in (30)b *PLANE-cl* must be a token realized in particular part of signing space, not a type.

- (30) For a context c , time of evaluation t and world of evaluation w :
- a. *PLANE*, normal noun
 $[[\text{PLANE}]]^{c, t, w} = \lambda x_e . \text{plane}'_{t, w}(x)$
 - b. *PLANE-cl*, classifier predicate [token]
 $[[\text{PLANE-cl}]]^{c, t, w} = \lambda x_e . \text{plane}'_{t, w}(x)$ and $\text{proj}(x, \pi_c, t, w) = \text{PLANE-cl}$

Evaluation is relative to a context c that provides the viewpoint, π_c . In the lexical entry for the normal noun in (30)a, *plane'* is a (metalinguage) predicate of individuals that applies to anything that is an airplane (*plane'* _{t, w} indicates that the predicate is evaluated at t in w). The classifier predicate has the lexical entry in (30)b. It has the same conventional component as the normal noun, but adds to it an (iconic) projective condition: for a token of the predicate *PLANE-cl* to be true of an object x , x should project onto this very token.

This difference between normal nouns and classifier predicates has clear semantic consequences when several classifier predicates occur in the same sentence. In (31)b, two tokens of *PLANE-cl* appear in positions a and b, and as the video makes clear, the two classifier predicates are signed as being close to each other and parallel. As a result, the sentence only makes an assertion about cases in which two airplanes take off next to each other or side by side. In contrast, with a normal noun, the assertion is that there is danger whenever two airplanes take off at the same time, irrespective of how close the two airplanes are, or how they are oriented relative to each other.

- (31) HERE ANYTIME __ SAME-TIME TAKE-OFF, DANGEROUS.
 'Here, whenever __ take off at the same time, there is danger.'
- a. ⁷ PLANE_a PLANE_b
 two planes
 - b. ⁷ PLANE-cl_a PLANE-cl_b
 two planes side by side/next to each other
 (ASL, 35, 1916, 4 judgments; <https://youtu.be/Wyt1AsP6ASk>)

4.3 Comparison

Once one has a pictorial semantics at one's disposal, one can go back to the demonstrative analysis of classifiers and make it more explicit. This can be seen in the comparison in (32). In (32)a, we include an analysis in the spirit of Zucchi (2011); for clarity, we add a subscript Z to the interpretation function. The Zucchian analysis includes a clause to the effect that the position of the denoted objects x must be similar to that of the airplane classifier, but it leaves entirely open what this similarity condition means (we have added a contextual subscript c to *similar*, as it is presumably a context-sensitive notion). The version in (32)b makes use of pictorial semantics to explicate the iconic component of classifier predicates. One may stick to the

analysis in (32)a and supplement it with a separate explication of the demonstrative component, as in (32)c. But this move presupposes rather than replaces an explicit pictorial account.

(32) Two analyses

a. Demonstrative analysis (in the spirit of Zucchi 2011)

$[[\text{PLANE-cl}]]_{Z^{c, s, t, w}} = \lambda x_e . \text{plane}'_{t, w}(x)$ and $\text{similar}_c(\text{location}(x), t, w, \text{PLANE-cl})$

b. Combined logical and iconic analysis

$[[\text{PLANE-cl}]]_{Z^{c, s, t, w}} = \lambda x_e . \text{plane}'_{t, w}(x)$ and $\text{proj}(x, \pi_c, t, w) = \text{PLANE-c}$.

c. For any context c , entity x , time t and world w , $\text{similar}(\text{location}(x), t, w, \text{PLANE-cl})$ iff $\text{proj}(x, \pi_c, t, w) = \text{PLANE-cl}$.

4.4 Necessary refinements

To have a full explicit iconic semantics, one must contend with several differences between classifiers and pictures.

1. Classifier predicates have a conventional shape; only their position, orientation and movement is interpreted iconically (sometimes modifications of the conventional handshape can be interpreted iconically as well). This requires more sophisticated projection rules with a partly conventional component (of the type: a certain symbol appears in a certain position of the picture if an object of the right types projects onto that position).

2. Many classifier predicates are dynamic (in the sense of involving movement) rather than static; we investigated above a static version of *PLANE-cl*, but this was primarily for simplicity. Dynamic classifier predicates create in essence a visual animation of what their denotations do, and this requires the development of a semantics for visual animations.

3. Sign language classifiers are not two-dimensional pictures, but rather 3D representations. One can think of them as puppets whose shape needn't be interpreted literally, but whose position, orientation and movement can be iconically precise. This requires formal means that go beyond pictorial semantics.

The interaction between iconic representations and the sentences they appear in also requires further refinements. A first refinement pertains to the semantics. For simplicity, we assumed above that the viewpoint relative to which the iconic component of classifier predicates is evaluated is fixed by the context. Notably, though, in some cases, viewpoint choice can be dependent on a quantifier. In the example below, the meaning obtained is that in all classes, during the break, **for some salient viewpoint π associated with the class**, there is a student who leaves with the movement depicted relative to π ; a recent proposal (Schlenker and Lamberton, to appear) has viewpoint variables in the object language, and they may be left free or bound by default existential quantifiers, as illustrated in (34).

(33) *Context*: This school has 4 classrooms, one for each of 4 teachers (each teacher always teaches in the same classroom).

CLASS BREAK ALL ALWAYS HAVE STUDENT PERSON-walk-back_right-cl.

In all classes, during the break, there is always a student that leaves toward the the back, to the right.'

(ASL, 35, 2254b)

Video: <https://youtu.be/h7EnRK6poAE>

(34) always $\exists \pi$ there-is student person-walk-cl $^\pi$

A second refinement pertains to the syntax. Across sign languages, classifier constructions may override the basic word order of the language; one possibility, which we return to below because it is shared with iconic gestures, is that that certain cases of non-standard syntax are also due to their iconic semantics.

5. Sign with Iconicity versus Speech with Gestures

5.1 Reintegrating gestures in the sign/speech comparison

The iconic contributions discussed above are partly different from those found in speech. Iconic modulations exist in speech (such as *looong* to mean 'very long') but are probably less diverse than those found in sign. Repetition-based plurals and pluractionals exist in speech (Rubino 2013), and it has been argued that for pluractional ideophones in some languages, the number of repetitions can reflect the number of denoted events (Henderson 2016). But sign language repetitions can iconically convey a particularly rich amount of information, including through their punctuated or unpunctuated nature, and sometimes through their arrangement in space (Schlenker and Lamberton 2022). As for iconic pronouns and classifier predicates, they just have no clear counterparts in speech. From this perspective, speech appears as 'iconically challenged' relative to sign.


But Goldin-Meadow and Brentari (2017) have argued that a typological comparison between sign language and spoken language makes little sense if it does not take gestures into account: sign with iconicity should be compared to speech with gestures rather than to speech alone, since gestures are the main exponent of iconic enrichments in spoken language. This raises a question: From a semantic perspective, does speech with gesture have the same expressive effect and the same grammatical integration as sign with iconicity?


5.2 Typology of iconic contributions in speech and in sign


This question has motivated a systematic study of iconic enrichments across sign and speech, and this has led to the discovery of fine-grained differences (Schlenker 2018b). The key issue pertains to the place of different iconic contributions in the typology of inferences, which includes at-issue contributions and non-at-issue ones, notably presuppositions and supplements (the latter are the semantic contributions of appositive relative clauses).

While detailed work is still limited, several iconic constructions in sign language have been argued to make at-issue contributions (sometimes alongside non-at-issue ones). This is the case of iconic modulations of verbs, as for *GROW* in (21), of repetition-based plurals and pluractionals, and of classifier predicates (on the other hand, the iconic contribution of sign language pronouns is thought to be presuppositional; such is also the case of the gender features of English pronouns, e.g. *she* triggers the presupposition that the denoted person is/identifies as female).




By contrast, gestures that accompany spoken words have been argued in several studies (starting with the pioneering one by Ebert and Ebert 2014) to make primarily non-at-issue contributions. Recent typologies distinguish between co-speech gestures, which co-occur with the spoken words they modify (a slapping gesture co-occurs with *punish* in (35)a); post-speech gestures, which follow the words they modify (the gesture follows *punish* in (35)b); and pro-speech gestures, which fully replace some words (the slapping gesture has the function of a verb in (36)c).

(35) a. Co-speech: His enemy, Asterix will _punish.

b. Post-speech: His enemy, Asterix will punish—.

c. Pro-speech His enemy, Asterix will .

When different tests are applied, such as embedding under negation, these three types display different semantic behaviors. Co-speech gestures have been argued to trigger conditionalized presuppositions, as in (36)a. Post-speech gestures have been argued to display the behavior of appositive relative clauses, and in particular to be deviant in some negative environments, as illustrated in (36)b-b'; in addition, post-speech gestures, just like appositive relative clauses, usually make non-at-issue contributions.

- (36) a. Co-speech: His enemy, Asterix won't  _punish.
=> if Asterix were to punish his enemy, slapping would be involved
- b. Post-speech: #His enemy, Asterix won't punish—.
b'. #His enemy, Asterix won't punish, which will involve slapping him.
- c. Pro-speech His enemy, Asterix won't .
=> Asterix won't slap his enemy

Only pro-speech gestures, as in (36)c, make at-issue contributions by default (possibly in addition to other contributions). In this respect, they 'match' the behavior of iconic modulations, iconic plurals and pluractionals, and classifier predicates. But unlike these, pro-speech gestures are not words and are correspondingly expressively limited. For instance, *UNDERSTAND* and especially *REFLECT* can be modulated in rich iconic ways in LSF, but there are no clear pro-speech gestures with the same abstract meaning.

In sum, while the reintegration of gestures into the study of speech opens new avenues of comparison between speech with iconicity and speech with gestures, one should not jump to the conclusion that these enriched objects display the same semantic behavior.

5.3 Classifier predicates and pro-speech gestures

Unlike gestures in general and pro-speech gestures in particular, classifier predicates have a conventional form (only the position, orientation, and movement are iconically interpreted, accompanied in limited cases by some aspects of the handshape). But there are still striking similarities between pro-speech gestures and classifier predicates.

First, on a semantic level, the iconic semantics sketched for classifier predicates in Section 4.2 seems useful for pro-speech gestures as well, sometimes down to the details—for instance, it has been argued that the dependency between viewpoints and quantifiers illustrated in (33) has a counterpart with pro-speech gestures (Schlenker and Lamberton, to appear).

Second, on a syntactic level, classifier predicates often display a different word order from other constructions, something that has been found across languages (Pavlič 2016). In ASL, the basic word order is SVO, but preverbal objects are preferred if the verb is a classifier predicate, for instance one that represents a crocodile moving and eating up a ball (as is standard in syntax, the 'basic' or underlying word order may be modified on independent grounds by further operations, for instance ones that involve topics and focus; we are not talking about such modifications of the word order here).

It has been proposed that the non-standard word order is directly related to the iconic properties of classifier predicates. The idea is that these create a visual animation of an action, and preferably take their argument in the order in which their denotations are visible (Schlenker et al, to appear; see also Napoli et al. 2017). One would typically see a ball and a crocodile before seeing the eating, hence the preference for preverbal objects (note that the subject is preverbal anyway in ASL). A key argument for this idea is that when one considers

a minimally different sentence involving a crocodile spitting out a ball it had previously ingested, SVO order is regained, in accordance with the fact that an observer would see the object after the action in this case (if a preverbal object is used, one tends to get the wrong meaning, e.g. the crocodile spit something on the ball).

Strikingly, these findings carry over to pro-speech gestures. It is an old observation, due to Goldin-Meadow and colleagues (2018), that when speakers of languages with diverse word orders are asked to use pantomime to describe an event with an agent and a patient, they tend to go with SOV order, including if this goes against the basic word order of their language (as is the case in English). Similarly, pre-verbal objects are preferred in sequences of pro-speech gestures in French (despite the fact that the basic word order of the language is SVO); this is for instance the case for a sequence of pro-speech gestures that means that a crocodile ate up a ball. Remarkably, with spit-out-type gestural predicates, an SVO order is regained, just as is the case with ASL classifier predicates (Schlenker et al, to appear, following in part by Christensen et al. 2016; Napoli et al. 2017; Schouwstra and de Swart 2014). This suggests that iconicity, an obvious commonality between the two constructions, might indeed be responsible for the non-standard word order.

6. Universal Properties of the Signed Modality

6.1 Sign language typology and sign language emergence

The properties surveyed above exist in several and probably many sign languages. Historically unrelated sign languages are routinely treated as a 'language family' in linguistics because they share numerous properties that are not shared by spoken languages (Sandler and Lillo-Martin 2006). Of course, this still allows for considerable variation across sign languages, for instance with respect to word order (e.g. ASL is SVO, LIS is SOV).

Cases of convergence also exist in language emergence. Homesigners are deaf individuals who are not in contact with an established sign language and thus have to develop their own gesture systems to communicate with their families. While homesigners do not invent a sign language, in several cases they appear to discover on their own certain properties of mature sign languages. Loci and repetition-based plurals are cases in point (Coppola and So 2006; Coppola et al. 2013). In a striking study, Coppola and colleagues (2013) showed in a production experiment that a group of homesigners from Nicaragua used both punctuated and unpunctuated repetitions, with the kinds of semantic distinctions found in mature sign language. Specifically, punctuated repetitions were used for 'exactly' meanings (e.g. with three iterations used to represent three objects). By contrast, a pair of unpunctuated iterations could be used to describe scenes with diverse plural quantities. In a second study, Coppola et. al "examined a child homesigner and his hearing mother, and found that the child's number gestures displayed all of the properties found in the adult homesigners' gestures, but his mother's gestures did not". This provided clear evidence that this homesigner had invented this plural device.

In sum, there is striking typological convergence among historically unrelated sign languages, and homesigners can in some cases discover grammatical devices found in mature sign languages.

6.2 Sign language grammar and gestural grammar

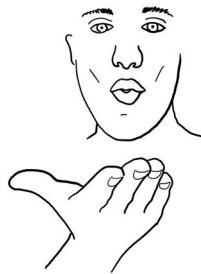
It is arguably possible to have non-signers discover on the fly certain non-trivial properties of sign languages (Strickland et al. 2015; Schlenker 2020). One possible procedure is to construct hybrids of words and gestures. We saw a version of this line of analysis in Section 5.3, when we discussed similarities between pro-speech gestures and classifier predicates. The result was that along several dimensions, notably word order preferences and associated meanings, pro-speech gestures resemble ASL classifier predicates (they also differ from them in not having lexical forms).

More generally, hybrid sequences of words and gestures have been used to determine whether non-signers might have access to a kind of gestural grammar somewhat reminiscent of sign languages (it goes without

saying that there is no claim whatsoever that non-signers know the sophisticated grammars of sign languages, any more than a naive monolingual English speaker knows the grammar of Mandarin or Hebrew). In one experimental study (summarized in Schlenker 2020), gestures with a verbal meaning, such as 'send kisses', targeted different positions, corresponding to the addressee or some third person, as illustrated below.

(37) A gesture for 'send kisses to' oriented towards the addressee or some third person position

a. send kisses to you



b. send kisses to him/her



This difference between these two forms is reminiscent of the distinction found in the agreement verb *TELL* in ASL: in (5), the verb could target the addressee position to mean *I tell you*, or some position to the side to mean *I tell him/her*. The experimental study showed that non-signers immediately perceived a distinction between the second person object form and the third person object form of the gestural verb, despite the fact that English, unlike ASL, has no object agreement markers. In other words, non-signers seemed to treat the directionality of the gestural verb as a kind of agreement marker. More fine-grained properties of the ASL object agreement construction were tested with gestures, again with positive results.

More broadly, non-experimental studies have argued that aspects of gestural grammar resemble ASL grammar in designated cases involving loci, repetition-based plurals and pluractionals, Role Shift and telicity marking. These findings have yet to be confirmed with experimental means. If they are correct, the question is why.

6.3 Why convergence?

We have seen three cases of somewhat surprising convergence in the visual modality: typological convergence among unrelated sign languages, homesigners' ability to discover designated aspects of sign language grammar, and possibly the existence of a gestural grammar somewhat reminiscent of sign language in designated cases. None of these cases should be exaggerated. While typologically they belong to a language family, sign languages are very diverse, varying on all levels of linguistic structure. As for homesigners, the gestural systems they develop compensate for the *lack* of access to a sign language; indeed, homesigners bear consequences of lack of access to a native language (see for instance Morford and Hänel-Faulhaber 2011; Gagne and Coppola 2017). Finally, non-signers cannot guess anything about sign languages apart from a few designated properties.

Still, these cases of convergence should be explained. There are at least three conceivable directions, which might have different areas of applicability. One possibility is that Chomsky's Universal Grammar (see for instance Pinker 1994) doesn't just specify abstract features and rules, but also certain form-to-meaning mappings in the visual modality. This might for instance have some plausibility when it comes to the use of pointing to realize pronouns in sign language.

A second possibility is that some expressive mechanisms found in the visual modality (be it signed or gestural) are different from those of the spoken modality. An example was discussed in Section 5.3 in relation to the word order differences between classifier predicates and normal signs, and between gesture sequences

and normal words. The hypothesis was that classifier predicates and gestural verbs create a visual animation, and for this reason they prefer to take their arguments in an order that mirrors the order in which their denotations would typically be visible.

A third possibility is that, for reasons that have yet to be determined, the visual modality sometimes makes it possible to realize in a more uniform fashion some deeper cognitive properties of linguistic expressions.

7. Future Issues

Additional issues pertain to methods and topical extensions of sign language semantics.

One issue pertains to the optimal balance between fine-grained semantic studies and robust methods of data collection: while disagreements among researchers abound, few experimental studies have sought to address which data collection methods are optimal. One thing is clear: just as is the case for spoken language, fine-grained judgments on numerous complex sentences and scenarios are typically needed for serious research on sign language semantics.

A second issue pertains to the involvement of native signers and Deaf researchers. There are multiple reasons for which they should play a central role, including because they have far better access to the data and to their broader social relevance than non-native signers and non-Deaf researchers.

A third issue involves the integration of sign language research to the program of formal semantics and pragmatics. Standards of formal accuracy and rigor should be the same for speech and for sign, but given the paucity of formal work on sign languages, this ideal is hard to achieve. In addition, work on formal pragmatics of sign language is still in its infancy, and should be developed systematically in the future.

Last, but not least, the philosophy of language should take sign languages into account. For the moment, it almost never does so.

Bibliography

- Abusch, Dorit, 2020, "Possible worlds semantics for pictures," in Lisa Matthewson, Cecile Meier, Hotze Rullmann, and Thomas Ede Zimmermann (eds.), *The Wiley Blackwell Companion to Semantics*, Wiley.
- Anand, Pranav, and Andrew Nevins, 2004, "Shifty Operators in Changing Contexts," in Robert Young (ed.), *SALT XIV*, Ithaca, NY: Cornell University, pp. 20-37.
- Anand, Pranav, 2006, *De De Se*. Ph.D dissertation, University of California, Santa Cruz.
- Aristodemo, Valentina, 2017, *Gradable Constructions in Italian Sign Language*. Doctoral dissertation Ecole des Hautes Etudes en Sciences Sociales, Paris.
- Barberà, Gemma, 2015, *The meaning of space in sign language: Reference, specificity, and structure in Catalan Sign Language discourse*. Preston, UK: Ishara Press.
- Beck, Sigrid, Sveta Krasikova, Daniel Fleischer, Remus Gergel, Stefan Hofstetter, Christiane Savelsberg, John Vanderelst, and Elisabeth Villalta, 2009, "Crosslinguistic variation in comparison constructions," *Linguistic Variation Yearbook*, 9: 1–66.
- Bellugi, Ursula, and Susan Fischer, 1972, "A comparison of sign language and spoken language," *Cognition*, 1(2–3): 173–200. doi: 10.1016/0010-0277(72)90018-2.
- Cable, Seth, 2011, "Understudied and Endangered Languages at the Semantics/Syntax Interface," presented at 50 Years of Linguistics at MIT: A Scientific Reunion, December 10th, 2011. <http://ling50.mit.edu/wp-content/uploads/Cable-handout.pdf>
- Christensen, Peer, Ricardo Fusaroli, and Kristian Tylén, 2016, "Environmental constraints shaping constituent order in emerging communication systems: Structural iconicity, interactive alignment and conventionalization," *Cognition*, 146: 67-80.
- Cogill-Koez, Dorothea, 2000, "Signed language classifier predicates: Linguistic structures or schematic visual representation?," *Sign Language and Linguistics*, 3(2):153-207.
- Coppola, Marie, and Wing Chee So, 2006, "The Seeds of Spatial Grammar: Spatial Modulation and Coreference in Homesigning and Hearing adults," in David Bamman, Tatiana Magnitskaia, and Colleen Zaller (eds.), *Proceedings of the 30th Boston University Conference on Language Development*, Boston: Cascadilla Press, pp. 119-130.
- Coppola, Marie, Elizabet Spaepen, and Susan Goldin-Meadow, 2013, "Communicating about quantity without a language model: Number devices in homesign grammar," *Cognitive Psychology*, 67: 1-25.
- Corina, David P., and Nicole Spotswood, 2012, "Neurolinguistics", in Roland Pfau, Markus Steinbach, and Bencie Woll (Eds.), *Sign language. An international handbook*, Berlin, Germany: Mouton de Gruyter, pp. 739–762.
- Cresswell, Max J., 1990, *Entities and Indices*. Kluwer.
- Cuxac, Christian, and Marie-Anne Sallandre, 2007, "Iconicity and arbitrariness in French Sign Language: Highly iconic structures, degenerated iconicity and diagrammatic iconicity," in Elena Pizzuto, Paola Pietrandrea, and Raffaele Simone (eds.), *Verbal and signed languages: Comparing structures, constructs and methodologies*, Berlin: Mouton de Gruyter, pp 13-33.
- Davidson, Kathryn, 2013, "'And' or 'or': General use coordination in ASL," *Semantics and Pragmatics*, 6(4): 1–44.
- Davidson, Kathryn, 2015, "Quotation, Demonstration, and Iconicity," *Linguistics & Philosophy*, 38: 477-520.

- Davidson, Kathryn, and Deanna Gagne, 2022, "'More is up' for domain restriction in ASL," *Semantics & Pragmatics*, 15: 1-EA. doi: <http://dx.doi.org/10.3765/sp.15.1>
- Davidson, Kathryn, Annemarie Kocab, Andrea D. Sims, and Laura Wagner, 2019, "The relationship between verbal form and event structure in sign languages," *Glossa: a journal of general linguistics*, 4(1): 123. doi: <https://doi.org/10.5334/gjgl.924>
- Deal, Amy Rolse, 2020, *A Theory of Indexical Shift: Meaning, Grammar, and Crosslinguistic Variation*. MIT Press.
- Ebert, Cornelia and Chrisitan Ebert, 2014, "Gestures, demonstratives, and the attributive / referential distinction", slides of talk at Semantics and Philosophy in Europe 7, ZAS, Berlin, <http://www.semanticsarchive.net/Archive/GJjYzkWn/EbertEbert-SPE-2014-slides.pdf>.
- Elbourne, Paul, 2005, *Situations and individuals*, Cambridge, MA: MIT Press.
- Emmorey, Karen, 2002, *Language, cognition, and the brain: Insights from sign language research*, Mahwah, NJ: Erlbaum.
- Emmorey, Karen, 2014, "Iconicity as structure mapping," *Philosophical transactions of the Royal Society B : Biological sciences*, 369(1651): 20130301.
- Emmorey, Karen, and Melissa Herzig, 2003, "Categorical versus gradient properties of classifier constructions in ASL," in Karen Emmorey (Ed.), *Perspectives on Classifier Constructions in Signed Languages*, Lawrence Erlbaum Associates, Mahwah NJ, pp. 222–246.
- Evans, Gareth, 1980, "Pronouns", *Linguistic Inquiry*, 11(2): 337–362.
- Frederiksen, Anne Therese, and Rachel I. Mayberry, 2022, "Pronoun Production and Comprehension in American Sign Language: The Interaction of Space, Grammar, and Semantics," *Language, Cognition and Neuroscience*, 37(1): 80-102. doi: 10.1080/23273798.2021.1968013
- Gagne, Deanna L., and Marie Coppola, 2017, "Visible social interactions do not support the development of false belief understanding in the absence of linguistic input: Evidence from deaf adult homesigners," *Frontiers in Psychology*, 8: 837.
- Geach, Peter, 1962, *Reference and generality. An examination of some medieval and modern theories*, Ithaca, NY: Cornell University Press.
- 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: e46.
- Goldin-Meadow, Susan, Wing Chee So, Asli Özyürek, and Carolyn Mylander, 2008, "The natural order of events: How speakers of different languages represent events nonverbally," *Proceedings of the National Academy of Sciences*, 105(27): 9163-9168.
- Greenberg, Gabriel, 2013, "Beyond Resemblance," *Philosophical Review*, 122(2): 215-287.
- —, 2014, "Reference and Predication in Pictorial Representation," Handout of a talk given at the London Aesthetics Forum (February 19, 2014).
- —, 2021, "Semantics of Pictorial Space," *Review of Philosophy and Psychology*, 12(4): 847-887.
- Heim, Irene, 1982, *The semantics of definite and indefinite noun phrases*, Ph.D. Dissertation, University of Massachusetts, Amherst.
- —, 1990, "E-type pronouns and donkey anaphora," *Linguistics and Philosophy*, 13: 137-177.
- Henderson, Robert, 2016, "A demonstration-based account of (pluractional) ideophones", in Mary Moroney, Carol-Rose Little, Jacob Collard, and Dan Burgdorf (eds), *Proceedings of Semantics and Linguistic Theory 26*. doi: 10.3765/salt.v26i0.3786.
- Herrmann, Annika, and Markus Steinbach, 2012, "Quotation in sign languages - a visible context shift," in Ingrid van Alphen, and Isabelle Buchstaller (eds.), *Quotatives: Crosslinguistic and cross disciplinary perspectives*, John Benjamins B.V., Amsterdam, The Netherlands, p. 33.

- Jacobson, Pauline, 1999, "Towards a variable free semantics," *Linguistics and Philosophy*, 22:117-184.
- —, 2012, "Direct Compositionality and 'Uninterpretability': The Case of (Sometimes) 'Uninterpretable' Features on Pronouns," *Journal of Semantics*, 29: 305-343.
- Kamp, Hans, 1981, "A theory of truth and semantic representation," in Jeroen A. G. Groenendijk, Theo M. V. Janssen, and Martin J. B. Stokhof (Eds.), *Formal methods in the study of language*, Amsterdam: Mathematical Centre.
- Klein, Ewan, 1980, "A semantics for positive and comparative adjectives," *Linguistics and Philosophy*, 4: 1-45.
- Koulidobrova, Elena, 2011, *SELF: Intensifier and 'long distance' effects in American Sign Language (ASL)*, Manuscript, University of Connecticut.
- Kuhn, Jeremy, 2015, *Cross-categorial singular and plural reference in sign language*. Doctoral dissertation, New York University.
- —, 2016, "ASL Loci: Variables or Features?," *Journal of Semantics*, 33(3): 449-491.
- —, 2021, "Discourse anaphora – Theoretical and Experimental Perspectives", in Josep Quer, Roland Pfau, and Annika Herrmann (Eds.), *The Routledge Handbook of Theoretical and Experimental Sign Language Research*, Routledge, pp. 458-479.
- Kuhn, Jeremy, and Valentina Aristodemo, 2017, "Pluractionality, iconicity, and scope in French Sign Language," *Semantics and Pragmatics*, 10(6): 1-49.
- Lane, Harlan, 1989, *When the Mind Hears: A History of the Deaf*. Vintage.
- Liddell, Scott K., 1984, "Unrealized-inceptive aspect in American Sign Language: Feature insertion in syllabic frames," *Proceedings of CLS 20*, p. 257-270.
- —, 2003, *Grammar, Gesture, and Meaning in American Sign Language*. Cambridge: Cambridge University Press.
- Lillo-Martin, Diane, 2012, "Utterance reports and constructed action," in Roland Pfau, Markus Steinbach, and Bencie Woll, *Sign Language: An International Handbook*. De Gruyter Mouton, pp. 365-387.
- Lillo-Martin, Diane, and Edward S. Klima, 1990, "Pointing out Differences: ASL Pronouns in Syntactic Theory," in Susan D. Fischer, and Patricia Siple (Eds.), *Theoretical Issues in Sign Language Research*, Chicago: The University of Chicago Press, Volume 1: Linguistics, pp. 191-210.
- Lin, Hao, Jeremy Kuhn, Huan Sheng, and Philippe Schlenker, 2021, "Timelines and Temporal Pointing in Chinese Sign Language," *Glossa: a journal of general linguistics*, 6(1) <https://www.glossa-journal.org/article/id/5836/>
- MacSweeney, Mairéad, Cheryl M. Capek, Ruth Campbell, and Bencie Woll, 2008, "The signing brain: the neurobiology of sign language," *Trends in Cognitive Sciences*, 12: 432-440.
- Malaia, Evie, Ronnie B. Wilbur, and Marina Milković, 2013, "Kinematic parameters of signed verbs," *Journal of Speech, Language, and Hearing Research*, 56: 1-12. doi: 10.1044/1092-4388(2013/12-0257)
- Matthewson, Lisa, 2001, "Quantification and the Nature of Cross-Linguistic Variation," *Natural Language Semantics*, 9: 145-189.
- Meir, Irit, Wendy Sandler, Carol Padden, and Mark Aronoff, 2010, "Emerging sign languages," in Marc Marschark and Patricia Spencer (eds), *Oxford Handbook of Deaf Studies, Language, and Education*, Oxford: Oxford University Press, 2: 267–280.
- Milković, Marina, 2011, *Verb classes in Croatian Sign Language (HZJ): Syntactic and semantic properties*. PhD thesis, University of Zagreb, Croatia.

- Moltmann, Friederike, 2017, "Natural Language Ontology," *Oxford Encyclopedia of Linguistics*.
- Morford, Jill P., and Barbara Hänel-Faulhaber, 2011, "Homesigners as Late Learners: Connecting the Dots from Delayed Acquisition in Childhood to Sign Language Processing in Adulthood," *Language and Linguistics Compass*, 5: 525-537. <https://doi.org/10.1111/j.1749-818X.2011.00296.x>
- Napoli, Donna Jo, Nancy K. Mellon, John K. Niparko, Chrisitan Rathmann, Gaurav Mathur, Tom Humphries, Theresa Handley, Sasha Scambler, and John D. Lantos, 2015, "Should All Deaf Children Learn Sign Language?," *Pediatrics*, 136(1): 170-176.
- Napoli, Donna Jo, Rachel Sutton-Spence, and Ronice Müller de Quadros, 2017, "Influence of predicate sense on word order in sign languages: Intensional and extensional verbs," *Language* 93(3): 641–670. doi: <https://doi.org/10.1353/lan.2017.0039>
- Neidle, Carol, Judy Kegl, Dawn MacLaughlin, Benjamin Bahan, and Robert G. Lee, 2000, *The Syntax of American Sign Language: Functional Categories and Hierarchical Structure*, MIT Press. Cambridge, MA.
- Ohori, Toshio, 2004, "Coordination in mentalese," in Martin Haspelmath (ed.), *Coordinating constructions*, Amsterdam: John Benjamins Publishing Co, pp. 41–66.
- Padden, Carol A., 1986, "Verbs and role-shifting in American Sign Language," *Proceedings of the Fourth National Symposium on Sign Language Research and Teaching*, Silver Spring, MD: National Association of the Deaf.
- Partee, Barbara, 1973, "Some structural analogies between tenses and pronouns in English," *The Journal of Philosophy*, 70: 601-609.
- Pavlič, Matic, 2016, *The word order parameter in Slovenian Sign Language Transitive, ditransitive, classifier and locative constructions*. PhD dissertation, University of Venice.
- Pfau, Roland, and Markus Steinbach, 2006, "Pluralization in sign and in speech: A cross-modal typological study," *Linguistic Typology*, 10: 49-135.
- 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. doi: <https://doi.org/10.5334/gjgl.511>
- Pinker, Steven, 1994, *The Language Instinct: How the Mind Creates Language*. New York: William Morrow.
- Postal, Paul, 1966, "On so-called 'pronouns' in English," *Report on the seventeenth annual round table meeting on linguistics and language studies*, Washington, DC: Georgetown University Press, pp. 177–206
- Quer, Josep, 2005, "Context shift and indexical variables in sign languages," *Proceedings of Semantic and Linguistic Theory (= SALT) XV*, Ithaca, NY: CLC Publications.
- —, 2013, "Attitude ascriptions in sign languages and role shift," in Leah C. Geer (ed.), *Proceedings of the 13th Meeting of the Texas Linguistics Society*, Austin: Texas Linguistics Forum, pp. 12-28.
- Quine, Williard V., 1960, "Variables explained away," *Proceedings of the American Philosophical Society*, 104(3): 343-347.
- Ramchand, Gillian, 2008. *Verb meaning and the lexicon: a first-phase syntax*. Cambridge University Press, Cambridge, UK.
- Rothstein, Susan, 2004, *Structuring Events: A Study in the Semantics of Lexical Aspect*. (Explorations in Semantics 2). Malden, MA & Oxford: Blackwell.
- Rubino, Carl, 2013, "Reduplication," in Dryer Matthew S., and Martin Haspelmath (eds.), *WALS Online* (v2020.3) [Data set]. Zenodo. <https://doi.org/10.5281/zenodo.7385533> (Available online at <http://wals.info/chapter/27>)

- Sandler, Wendy, and Diane Lillo-Martin, 2006, *Sign Language and Linguistic Universals*, Cambridge University Press.
- Sapir, Edward, 1921, *Language: an introduction to the study of speech*, Harcourt Brace, New York, NY.
- Schlenker, Philippe, 2018a, “Visible Meaning: Sign Language and the Foundations of Semantics,” *Theoretical Linguistics*, 44(3-4): 123-208.
- —, 2018b, “Iconic Pragmatics,” *Natural Language & Linguistic Theory*, 36(3): 877-936.
- —, 2020, “Gestural Grammar,” *Natural Language & Linguistic Theory*, 38: 887-936.
- Schlenker, Philippe, Marion Bonnet, Jonathan Lamberton, Jason Lamberton, Emmanuel Chemla, Mirko Santoro, and Carlo Geraci, to appear, “Iconic Syntax: Sign Language Classifier Predicates and Gesture Sequences,” *Linguistics & Philosophy*.
- Schlenker, Philippe, and Jonathan Lamberton, 2022, “Meaningful Blurs: the Sources of Repetition-based Plurals in ASL,” *Linguistics & Philosophy*, 45: 201–264.
- —, accepted with minor revisions, “Iconological Semantics,” *Linguistics & Philosophy*.
- Schouwstra, Marieke, and Henriëtte de Swart, 2014, “The Semantic Origins of Word Order,” *Cognition*, 131(3): 431–436.
- Steinbach, Markus, and Edgar Onea, 2016, “A DRT Analysis of Discourse Referents and Anaphora Resolution in Sign Language,” *Journal of Semantics*, 33: 409–448.
- Stone, Matthew, 1997, “The anaphoric parallel between modality and tense,” *Technical Reports (CIS)*, Philadelphia, PA: University of Pennsylvania Press.
- Strickland, Brent, Carlo Geraci, Emmanuel Chemla, Philippe Schlenker, Meltem Kelepir, and Roland Pfau, 2015, “Event representations constrain the structure of language: Sign language as a window into universally accessible linguistic biases,” *Proceedings of the National Academy of Sciences*, 112(19): 5968-5973.
- Supalla, Ted, 1982, *Structure and acquisition of verbs of motion and location in American Sign Language*. Ph.D. Thesis, University of California, San Diego.
- Taub, Sarah F., 2001, *Language from the body*, Cambridge University Press.
- Wilbur, Ronnie B., 1996, *Focus and specificity in ASL structures containing SELF*, LSA Annual Meeting.
- —, 2003, “Representations of telicity in ASL,” *Chicago Linguistic Society*, 39: 354-368.
- —, 2008, “Complex Predicates Involving Events, Time and Aspect: Is This Why Sign Languages Look So Similar?,” in Josep Quer (ed.), *Signs of the time: Selected papers from TISLR 2004*, Signum, Hamburg, pp. 217-250.
- Wilbur, Ronnie B., and Evie Malaia, 2008, “Event Visibility Hypothesis: Motion Capture Evidence for Overt Marking of Telicity in ASL,” Chicago, IL: Linguistic Society of America.
- Zucchi, Sandro, 2009, “Along the time line: tense and time adverbs in Italian Sign Language,” *Natural Language Semantics*, 17: 99-139.
- —, 2011, “Event Descriptions and Classifier Predicates in Sign Languages,” Presentation given at FEAST in Venice, June 21, 2011.
- —, 2012, “Formal Semantics of Sign Languages,” *Language and Linguistics Compass*, 6(11): 719-734.
- —, 2017, “Event Categorization in Sign Languages,” in Cohen Henri and Lefebvre Claire (eds.) *The Handbook of Categorization in Cognitive Science*, Elsevier, 2017, pp. 377-396