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Evolving methods for written representations of signed languages of the Deaf

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1. Introduction

Like all human languages, signed languages used in Deaf communities are analyzable according to many of the same linguistic models and constructs that are used for oral languages. The signed language linguist, however, is confronted with methodological problems stemming from the visual/corporal modality in which these languages are produced and perceived as well as the pervasive iconicity at all levels of the language. This chapter reviews some of the major methodological problems connected with the written representation of these languages, at the level of the isolated sign as well as signed texts, and then describes some newer projects and methodologies, many of which not only reflect revised theories that more accurately represent these languages but also utilize recent advances in computer and media technologies.

2. Research and written forms of data

Modern research on the signed languages used in Deaf communities began only in the 1960s, especially with Stokoe's work on American Sign Language (Stokoe 1960; Stokoe et al. 1965). In the following decades, several different kinds of methodologies have evolved for studying many different linguistic, psycholinguistic, sociolinguistic and neurolinguistic aspects of signed languages, not all of which can be described here. The focus of this discussion will be on one of the most basic methodological challenges faced by most of these research studies: How to transcribe, notate and/or write this visual/corporal language that has so many iconic elements.

A 2009 lecture series at the University of Bern invited speakers from different disciplines to discuss the relevance for natural and formal languages in the sciences of Ludwig Wittgenstein's proposition from his *Tractatus Logico-Philosophicus* first published in 1922 (Wittgenstein 1990, Prop. 7): "That about which one cannot talk, one must remain silent" ("Wovon man nicht sprechen kann, darüber muss man schweigen"). In my

contribution to this series, I proposed further restricting this proposition to "That which one cannot write down, one cannot research". Here, 'writing down' would include using script, symbols, diagrams or models and is based on the importance of a written form for development of science and scientific thinking. Goody (1987:76) argues that the development of science is based on accumulated records of 'proofs', which other scientists and other generations can review skeptically and improve upon.

Of course, sign language researchers have raw data in the form of videotapes of signing, just as unwritten 'oral languages' can be documented with tape recordings. However for research purposes, videos or recordings alone are not sufficient. One cannot make generalizations, formulate linguistic rules, conventions, or propose models if descriptions of the language can't be put in some written form, allowing one to look at them again and again, to share them with present and future generations of research colleagues of one's own and other signed languages.

The discussion that follows will focus on difficulties of written forms of these languages, related to two basic factors: the visual/corporal modality of these languages and the issue of iconicity.

3. Modality and the difficulty of representing signed languages

Signed languages are produced and perceived in the visual/corporal modality. Unlike oral languages, signed languages can use the 3-dimensional space surrounding the signer for linguistic purposes. Pronominal references are often made in signed languages by establishing and then referring back to directions or locations in the 'signing space'. The location, orientation and/or movement of agreement verbs are coordinated with these spatial (abstract as well as concrete) references, as are verbs indicating source and/or goal of actions. The referents involved in locative verbs are often not indicated with prepositions (on, under, etc.) but rather by directly indicating their spatial arrangement. Most signed languages also have developed spatial systems for a variety of temporal references, using several different kinds of spatial 'time-lines' to indicate present, past and future times as related either to the present (tomorrow, in two days, etc.) or some other specified temporal point ('before I go on vacation'). (Engberg-Pedersen 1993, for example, describes the timelines used in Danish Sign language.) A written representation of signed languages must therefore be able to adequately show all these linguistic uses of three-dimensional

space, not only in single lexical items but also in grammatically modified signs in signed texts.

The simultaneity of many of the linguistic components in visual/corporal languages in both production and perception also poses challenges for written representations (Vermeerbergen et al. 2007). One of the earliest phonological findings about signed languages was that the manual sign could be described by four parameters: the hand's handshape, its location, the orientation of the palm and fingers, as well as their movements. (For an overview of sign language phonology, see Klima and Bellugi 1979, Brentari 1998.) In some signs, the components in these parameters can be modified for phonological, semantic or morphosyntactic purposes. For example, by modifying the location and movement of an agreement verb, different pronominal references can be made; the sign for 'ask', for example, moves in different directions to express 'I ask him' vs. 'He asks me'.

Productive forms are also very prevalent in all sign languages. In the 'productive' vocabulary, change of the handshape and orientation alone can indicate, for example, whether a 'single person' is moving, or a 'large vehicle' or a 'two-wheeled vehicle' or a 'small animal'. As some oral languages, such as Navajo, add this information in the form of lexical classifiers, many sign language researchers also refer to the sign language productive forms as 'classifier signs'. (See Emmorey 2003 for an overview of this research.) Several factors influence these forms in signed languages, including not only lexical standardization and template visual representation, but also cognitive, processing, ease of production and context factors. In her study of classifier forms in different sign languages, Engberg-Pedersen (2010) provides a good discussion of these factors, which also draws on Talmy's (2000) description of foregrounding and backgrounding in spoken languages.

Productive forms provide the possibility of signing different meaning on each hand, which correspondingly increases the number of simultaneous linguistic units. For example, one hand can convey 'a tree is located' while the other hand shows a moving auto, to give the meaning 'an auto crashes into the tree'. A referent can be maintained in one hand, while the other hand signs a phrase, a clause, or a sentence pertaining to that referent.

Adding to the complexity of these simultaneous components are the 'non-manual' signals, which signers co-produce on the face and with the upper body. Similar facial or body signals used by speakers are often categorized as 'non-verbal' communication, and hence, being 'non-linguistic', are often omitted in transcriptions of spoken languages. It's not so easy for signed language linguists to relegate all simultaneously produced facial and body signals to the non-verbal, no-need-to-transcribe realm, as these

signals can operate linguistically at the semantic, and especially the morphosyntactic, prosodic and discourse levels (Wilber 2000; Pfau and Quer 2010; Sandler and Lillo-Martin 2006; Reilly and Anderson 2002). Research on several different signed languages has indicated that components of the upper face (eyebrows, eye shape) tend to be used to indicate sentence types (questions, relative clauses, etc.) whereas components of the lower face (mouth, cheeks) are used for more adjectival/adverbial information indicating the size, shape, ease, difficulty etc. Direction of eye gaze, as well as whole facial expressions and body postures are used at the discourse level for identifying discourse referents (see, for example, Cuxac and Pizzuto 2007, 2010). These signals are often used in 'constructed speech' or 'constructed action' sequences. The signer often makes rapid shifts between referents with these simultaneous signals, which can be the only means by which the viewer knows who is doing what to whom. Another kind of simultaneous non-manual signal found in many signed languages are 'mouthings', movements of the mouth which resemble pronunciation of oral language words or word parts and can have functions at the lexical, discourse and prosodic levels (Boyes Braem and Sutton-Spence 2001).

These simultaneous manual and non-manual components occur very often in signed discourse. They make the language a delight to watch, but, together with the linguistic use of the 3-dimensional signing space, a devil to notate. So how do researchers represent these visual languages? Interestingly, and somewhat bizarrely, a tradition has grown up of notating single lexical items with one system and transcribing signed texts with a completely different system.

4. Written representations of signs in isolation

In the standard literature on writing systems, there is almost no discussion of systems for signed languages. Rogers (2005) and Daniels (2001), for example, make no mention at all of signed languages. In the over 800 page earlier version of Daniel's *The World's Writing Systems*, the only reference that has tangential relevance to signed languages is a two-page description of 'Movement Notation Systems' (Daniels and Bright 1996: 862–864).

In fact, several different kinds of systems have been developed for the written representations of different aspects of signed languages for different purposes (see Miller 2001 for a general overview as well as Van der Hulst and Channon 2010 who discuss various systems of writing, notating and

coding sign languages and compare them to systems developed for oral languages.)

Here, three of the most widely used systems for representing the form of single signs in isolation will be briefly described: Stokoe and Hamburg Notation Systems (HNS), SignWriting (SW) and the Berkeley Notation System (BNS).

4.1. Stokoe and Hamburg Notation System (HNS)

One of the most widely used phonetic notation systems for forms of signs is HamNoSys (HNS). This system is based on the Stokoe Notation System, which was developed in the 1960s for American Sign Language (Stokoe 1965), but its approximately 150 symbols have been adapted and expanded for use with other sign languages (Prillwitz and Zienert 1990, Hanke 2004, Smith 2010). The symbols of both the Stokoe and the HNS notations are primarily for the manual components of the sign. A great advantage of the HNS system is that the symbols are a Unicode font that can be typed and hence all components are electronically searchable. The notation process has been made easier by the development of a signing 'Avatar', which performs the sign according to the notation, giving the person notating immediate feedback on the correctness of the notation (Figure 1).

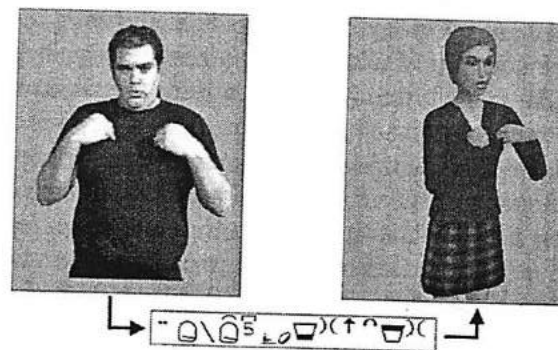


Figure 1. German Sign Language sign meaning 'morning': videotaped signing and the avatar reproduction based on the HamNoSys notation of the sign (Images from Morrissey et al. 2010)

At the present time, HamNoSys symbols do not adequately notate the non-manual aspects of signing (although preliminary steps have been taken to add this in the future). Another disadvantage of HNS is that its essentially linear representation of a single sign can be quite long and complex,

making it unwieldy for reading of sequences of signs in phrases, much less in lengthy texts. Figure 2 shows an example of the HNS notation of a sentence that means 'Goldilocks is wandering in a deep forest', and involves semantically modified forms of the signs meaning Goldilocks, wanders, and forest.

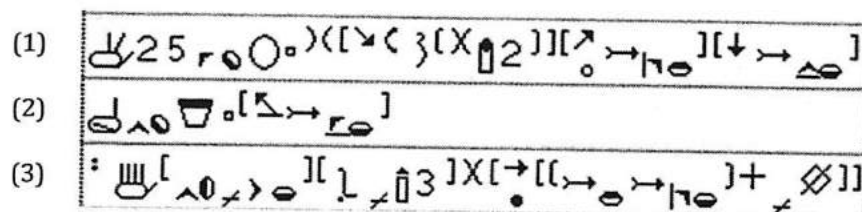


Figure 2. Example of the use of HamNoSys to represent a signed sentence meaning 'Goldilocks is wandering in a deep forest': (1) GOLDILOCKS (2) WANDER (3) THROUGH-FOREST (Bentele 1999: <http://sign-writing.org/forums/linguistics> No. 9 Writing the Same Signs in Different Transcription Systems: HamNoSys)

4.2. SignWriting (SW)

SignWriting (SW) is based on dance notation, which has been adapted for writing sign languages (www.signwriting.org). This writing system is intended to be used for everyday communication, including emails and text messages, and for writing down signed stories, poetry, history, etc. The advantages of SW are that the symbols are quite iconic and fairly easy to learn and that many non-manual components of the face and eye gaze direction are also represented. Many placements or directions in the signing space are shown graphically. An additional advantage of this system is that, because these non-manual and spatial components are represented, the signing can be reproduced from the written description alone, without reference to the video data. Di Renzo et al. (2006) found that this 'reproducibility' was true not only for the original transcriber of the Italian Sign Language texts but also by other signers who had never seen the original video data. Figure 3 is an example of SW used to represent a retelling of the story 'Noah and the Ark' in Swiss German Sign Language (Deutschschweizerische Gebärdensprache – DSGS). The symbols are to be read vertically, from top to bottom. English glosses have been added here to make the succession of signs clearer for the reader. The repetition of the sign to the left and right of the signer is a technique for indicating multiple instances of an event in this language.

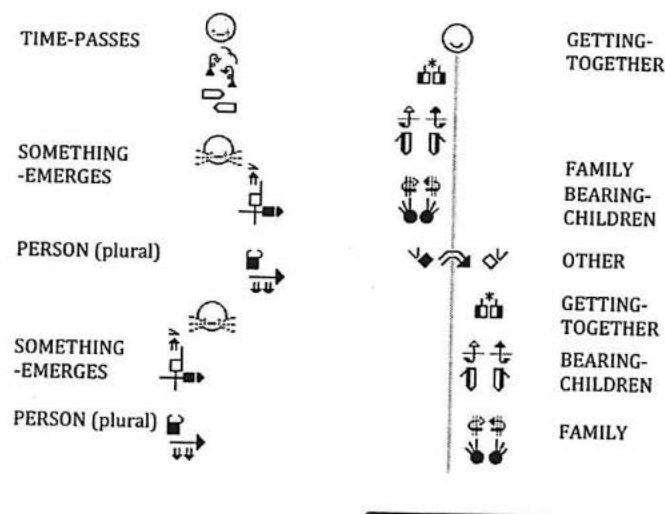


Figure 3. Example of SignWriting used for a sentence from a Swiss German Sign Language narration: 'After some time, people appeared; they formed groups, bore children, and founded families.' The repetition of the sign to the left and right of the signer is a technique for indicating multiple instances of an event. (Boyes Braem 2002)

One disadvantage of SignWriting is that it is sometimes unclear if the symbols are descriptions of the sign at the phonetic or the phonemic level. The founder of the system, Valerie Sutton has written that SignWriting "most definitely has been evolving from phonetic to phonemic. It has also gone from phonemic to phonetic at times, depending on the writer's needs" (Sutton 1998). The writing has been used, with more or less detail, for different purposes, resulting in more phonemic descriptions for lexicons but also more phonetic descriptions for signs in the transcription of sentences from signed texts. Another drawback for linguists is that the handshape and orientation parameters, which have been found to be phonologically linguistically independent, are conflated into one SW symbol, the orientation being indicated by the white and black portions of the symbol for the handshape.

SignWriting is not yet defined in Unicode, although recent proposals have been for this (<http://philippebeaudette.com/signwriting-goes-unicode/>). At the present time, although SW symbols can be electronically entered by clicking on and dragging a symbol, the symbols and their combinations are not stored as fonts but as images. Consequently, the researcher cannot electronically search separate symbols for linguistic components within the image. Other linguistically important information (such as the spatial

relationship of an articulator to another articulator, to linguistic landmarks of the body or linguistically significant spatial loci in the signing space) is also only indicated graphically, is un-coded and hence unsearchable.

Having said all this, it should be remembered that SignWriting was not developed for linguistic research purposes but primarily as a way of writing the language for everyday use. Thus, like writing systems for oral languages, it omits many factors that might be of interest for linguists. Pizzuto et al. (2008) found in their research on Italian Sign Language (LIS) that SW, as a writing system alone, could nevertheless have a value for research. Noting that for oral languages the existence of writing systems not only advanced the standardization processes of the language but also was a precursor to the development of transcriptions systems for research purposes, they argue that more widespread use of a writing system might also be a necessary precursor to developing adequate form/meaning transcriptions of signed languages. They feel that SW

has the potential for encoding structures and morphosyntactic organizational patterns that are highly specific of [signed languages], and that merge not only in their face-to-face form but also...in their written form. (Pizzuto et al. 2008: 5)

4.3. Berkeley Notation System (BNS)

Another writing system that has been developed for signed languages is the Berkeley Notation System (Hoiting and Slobin 2002). This system is analogous to the CHILDES system for annotating written forms of oral languages especially for acquisition studies. A disadvantage of the BNS for notation of single signs is that it notates the meaning, but not the form of the morphemes.

5. Representing signs in sentences and longer texts

5.1. ID-Glosses

Primarily in order to make transcriptions of sign sequences more easily readable and searchable, researchers have, over the years used a convention of representing signs in signed discourse with 'ID-glosses'. These glosses are written words from the oral language used in the same region as the sign language. They are not full translations of the sign but should reflect

part of the meaning of the sign lemma. To help distinguish words used as glosses from normal words or from full translations, they are written in all caps, and are either uninflected forms or stems of the oral language word. Glosses can be used alone to represent the signs in a phrase or sentence (WOMAN SLEEP: *The woman is sleeping*) or they can be embellished with other information to give additional linguistically relevant information. For example, signs functioning as proforms for personal pronouns can add information about the grammatical person involved (PROFORM_2 TELL PROFORM_3: *You tell him/her*). Other kinds of signs, for example those involving locomotion or location, can be appended with a wide variety of ad hoc abbreviations to describe where the sign is made or moving in the signing space (side-left_VEHICLE-MOVES_side-right: *The vehicle moves from here to here*). The main advantage of these glosses for researchers is, in addition to their readability, that they are machine searchable.

Despite their wide use by signed language researchers, glosses pose many problems for representing signs both in isolation and in signed texts. Pizzuto et al. (2006) point out that sign language researchers have used oral language glosses as the primary and only representation of the sign, as opposed to the use of glosses for oral languages where the gloss always accompanies another, primary representation of the form. The example in Figure 4 contrasts the use of glosses for 'He/she brought it' in the oral language Yoruba, a Nigerian language, with glosses for signs having a comparable meaning.

- (1) Use of glosses for oral languages, here the Nigerian language Yoruba for the sentence meaning 'He/she brought it' (Pulleyblank 1987: 988)

ó	gbé	e	wá
he/she	carry	it	come

- (2) Use of glosses for signed languages for a meaning comparable to that in (1)

INDEX-a	INDEX-b	BRING
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Figure 4. Comparison of the use of glosses (1) for oral language and (2) for signed language (Pizzuto et al. 2006:4)

The glosses for the signs provide no way to retrieve the sign's form. The 'gloss' BRING, for example, gives no inkling of how this sign is made. Pizzuto and Petrandrea (2001) point out that the use of glosses can also misrepresent the structure of signs and signed discourse. There is a further serious problem of meaning equivalency, i.e. of falsely attributing all the meanings (and word class) of the oral language word to the sign.

Finally, there is always a danger that different transcribers will use different glosses for the same sign, or the same gloss for different signs. For example, the gloss KRANK 'sick' has been used for different Swiss German (DSGS) signs, all of which have different forms and meanings (Figure 5).

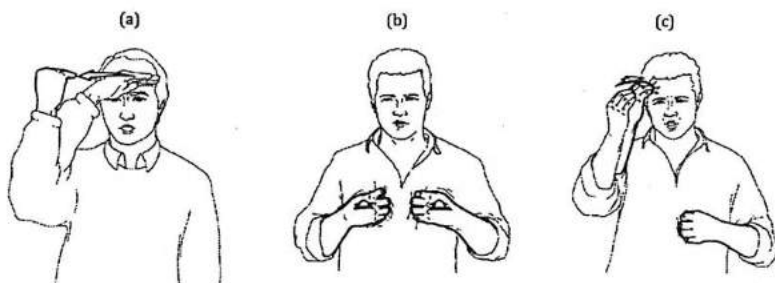


Figure 5. Example of one gloss (KRANK/sick) being used to represent different signs with different meanings: (a) physically sick, (b) psychologically sick, (c) cognitively sick (Boyes Braem 2005a)

5.2. Tiered Transcriptions (handwritten and in Excel)

One way of surmounting the representation problems described above is by transcribing different components of the signing on separate tiers of a transcription. At the minimum, there are tiers for glosses for the manual signs in the dominant and non-dominant hands. Additional tiers can annotate features which are not clear from the glosses, for example, non-manual components, constructed speech or action, etc. Depending on how detailed the analysis is, the resulting transcription can resemble a musical score for a single flute or a many-tiered score for full orchestra. The example in Figure 6 shows one of the first transcriptions of Swiss German Sign Language (DSGS), which was written in the spreadsheet software Excel (Boyes Braem 2001). Selected key points of the transcription are annotated with the time code of the original video data, but the transcript itself is not linked to the video data.

Gruppierung	6							
Zeit-Anfang	0.415	0.417	0.423	0.43	0.438	0.444	0.447	0.456
Zeit-Ende	0.417	0.423	0.429	0.438	0.443	0.447	0.455	0.466
Kopf/Kinn		Koo						
Körper								
Blick	ad(r)	*	# vl	# ad(r)	*	*	* #	vm("Wäsche")
Augen/Brauen								
Mund			lv	*				lv
Backe								
Nase								
Ausdruck								"beschäftigt"
Rolle								E/TBV)
nichtdom. Hd.								
beide-Hde.		SCHELL-MACHEN			BALKON		WASCHEN	HANGEN+ (v)
dom. Hd.	ICH		SchwB (vl)	IX (vbsl)		IX (sl)		
Mundbild	ich	schne	il		Ba	iken	wa	schen
Übersetzung	(5) Dann ging ich schnell auf den Balkon um die Wäsche aufzuhängen.							

Figure 6. Portion of an Excel transcription of a Swiss German Sign Language narrative

5.3. Tiered Transcriptions with tagged media software (ELAN)

The development of technology for 'tagging' video media in recent years has meant that transcriptions can be directly linked to the raw data in the video. Software such as the free application ELAN, developed for other kinds of research and for all computer platforms by the Max Planck Institute in Nijmegen is becoming widely used in recent years by signed language researchers (<http://www.lat-mpi.eu/tools/elan/>). Figure 7 is an example of some of the possibilities of an ELAN transcription. The researcher can create, add, view, and delete tiers according to the needs of the study. For signed language researchers, the constant availability of the original signing has helped offset the disadvantage of the complete form of the signing not being reflected in the glosses or notations systems used. When in doubt, one can always look at the ever-present video that flows along with the transcription.

5.4. Tiered Transcriptions with tagged media linked to a lexicon (iLex)

While having the raw data always available is helpful, it does not really solve the problem of an inconsistent attribution of glosses to signs. One attempt to overcome this problem is the iLex software developed over fifteen years of work on dictionaries for technical terms in German Sign Language (Deutsche Gebärdensprache, DGS) at the University of Hamburg (Konrad 2011). The iLex technology is similar to that of ELAN, but has the additional advantage of linking the glosses in a media-tagged transcript to

the glosses for sign lemma in a central lexicon. This linking has several advantages:

- The transcriber can easily check if the intended gloss for a sign in the text is the correct one by looking at the citation form in the lexicon, as well as descriptions of its meaning and other dictionary information about the form, variations and uses of the sign;
- Transcribers can in addition view how the sign is used in the context of other annotated video data linked to the lexicon;
- Lexicon users have, correspondingly, access not only to the usual dictionary information about the sign but also to the sign in context of all the linked videos.

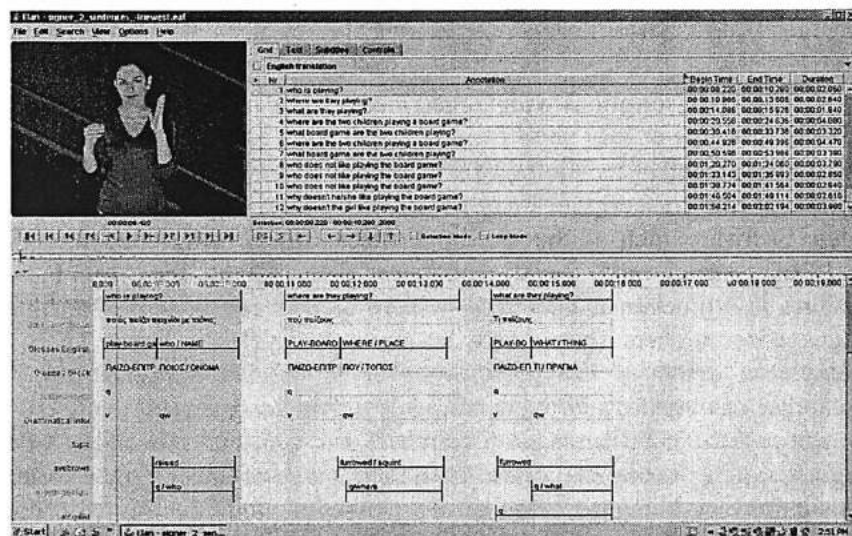


Figure 7. An example of a transcript from a Greek Sign Language corpus in the media-tagging program ELAN (Efthimiou et al 2009)

Figure 8 shows an example of an iLex transcription of German Sign Language linked to a lexicon.

Both the ELAN and iLex technologies have been developed for academic (i.e. not commercial) purposes and are available to researchers of other signed languages. The maintenance and continued development of both are also assured by the fact that large institutions stand behind the software.

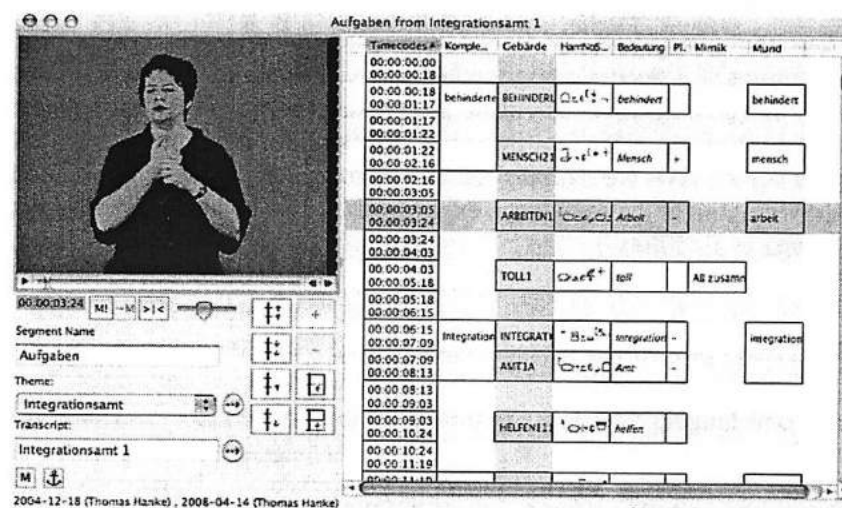


Figure 8. Example of an iLex transcription of German Sign Language (Hanke and Storz 2008)

6. Signed Language Corpora

6.1. Recent research on signed language corpora

All of these newer methodologies have made it finally possible to carry out corpora projects for signed languages. Years of research on oral language corpora have established their value for many different kinds of linguistic research, ranging from lexicography, to discourse analysis and acquisition studies. For endangered languages – a category to which signed languages belong (Johnston 2004: 358) – the documenting which corpora provide can be vital.

Konrad (2010) provides an overview of recent signed language corpus projects for 14 different signed languages. A European Cultural Heritage Online (ECHO) pilot project has produced an online corpus of Dutch, British and Swedish sign languages (<http://www.let.ru.nl/sign-lang/echo/>). Several Sign Corpora Network (<http://www.ru.nl/slcn/>) workshops have addressed, among other issues, metadata, ISO codes for signed languages, conventions for annotation, as well as exploitation and publication of signed corpora. Workshops at four recent Language Resources and Evaluation (LREC) conferences have increased international cooperation in this, for sign language, new field (Streiter and Vettori 2004; Vettori 2006; Crasborn et al. 2008; Drew et al. 2010).

One of the largest signed language corpora to date is a long term (2009-2024) project for documenting the 'everyday' lexicon of German Sign Language. The project involves videotaping a large corpus of data for a variety of different kinds of signing by signers throughout the country. The videotaped signed texts are then tagged and annotated in iLex, which is coordinated with, and at the same time expands, a central lexicon of the language (Prillwitz et al. 2008).

6.2. Privacy problem of signed language corpora on the Internet

Many oral language corpora are now available to the researcher, and some to the general public, on the Internet. For signed corpora, this web-presentation involves a privacy problem not faced by written corpora of oral languages. Whereas the identity of the original speaker of written corpora remains hidden, the identity of the person producing videotaped signed texts is readily accessible on the computer screen of the user, sometimes for many years into the future. For studio-produced videos, for which the signing models have given permission for the Web-publication of their faces, this isn't a problem. Researchers, however, often need to base their analyses on spontaneous signing of adults or children, not all of who are (or are not yet) aware of the consequences of a web-based publication of their signing. Who 'owns' this video data? What are the conditions for explaining, collecting permissions of use?

One workaround for this privacy issue is the use of signing avatars for web representations. There has been much recent work on signing avatars in several countries. Many of these projects are reported upon at the international conferences on research methodologies in sign language linguistics (TISLR 2010). A European Commission CORDIS project, Visicast, has developed an Avatar that signs information in British Sign Language at post offices (<http://www.visicast.co.uk/>). The project 'Trainslate' will translate German train announcements into avatar signed Swiss German Sign Language equivalents for Smartphones (<http://www.cl.uzh.ch/research/maschinelleuebersetzung/signlang.html>). The European Union project, DictaSign, aims to develop a prototype for a signing Wikipedia (www.Dictasign.eu) involving avatar technologies. The signer should be able to upload a contribution in the form of videotaped signed text. Visual recognition and visual language synthesis technologies would then reproduce the human signing in the original video with the signing of an avatar for publication of the text on the Web. The avatar should show all

the relevant semantic and grammatical features of the original signing, including the relevant linguistic non-manuals, but give no indication of the original human signer's identity. If this avatar technology becomes sufficiently developed, it could also theoretically be used to represent signing in signed corpora posted on the Internet (as well as on mobile phones and other hand-held devices).

7. The issue of iconicity

7.1. Arbitrariness vs. iconicity

The iconicity of signed languages has been a problem that has confronted linguists for decades. Theoretically, the question is should iconic elements be represented at all, and if so, as a mere modality effect or as an essential aspect of the language? Most researchers in the 1960s and 1970s felt that in order to qualify as a 'true language', signed languages had to conform to Saussure's dictum of the linguistic sign's 'arbitrariness', a term which by that time had come to mean the 'un-motivatedness' of the sign (Müller and Fischer 2003). Consequently, there has been a longstanding discussion about iconicity, which has included dissecting its meaning, determining whether, in isolated signs, the iconicity is 'transparent' or 'opaque', looking at the cultural relativity of iconic terms, and at the influence of iconicity on the rate and type of acquisition of signs by children and the learning of signs by adults. Many of the early descriptions of signed languages tended to focus on the obviously arbitrary elements of these languages. However, even as a growing number of research studies made it increasingly clear that signed languages are complex linguistic codes that have to be learned in order to be understood, the prevalence of iconicity, or 'visual representations', at all levels of the language stubbornly made it impossible to banish the topic from the focus of research.

Some early studies treated iconicity at the lexical level as a form of visual metaphor or metonym (Boyes Braem 1981, 1984, 1986). This metaphor/metonym approach was greatly accelerated by the growth in the 1980s and 90s of cognitive linguistics, especially by the work of linguists such as Lakoff and Johnston 1980, and Fauconnier and Sweetser 1996, upon whose theories newer metaphoric/metonymic approaches were made by signed language linguists such as Brennan (1990a), Cameracanna et al. (1994), Taub (2001), and Wilcox (1993, 2007). Figure 9 shows an example from

British Sign Language of the visual metaphor of 'grasping a thought' in the sign for the abstract concept 'understand'.



Figure 9. British Sign Language sign for 'understand' based on the visual metaphor combining (1) THINK and (2) GRASP (Brennan 1990b: 225)

7.2. Iconicity and the productive lexicon

The role of iconicity is especially difficult to ignore in signs belonging to what has been termed here the productive lexicon. These kinds of signs have been referred to in the literature over the years under various names, including 'depicting signs', 'classifier signs or constructions', 'highly or strongly polymorphemic structures', and 'highly iconic structures' (see, for example, the discussion highly iconic structures in Cuxac and Sallandre 2007). As mentioned in Section 3, agreement verbs can be modified to show grammatical persons. Another group of signs can be modified to reflect source, goal and manner of movement. Productive signs can further be modified to show the class of the referent object, or its size, shape and weight or how it can be manipulated by the human hand or other instruments. One description of these productive forms treats them as the result of a set of 'Bilderzeugungstechniken'/image generation techniques (Langer 2005). There are a very large number of possible productive forms. The use of specific productive forms in specific contexts is not obligatory, unlike most oral language classifiers, but depends on what the individual signer chooses to highlight in a particular context. (See the discussion of 'classifiers' in signed and spoken languages in Engberg-Pedersen 1993; Emmorey 2003.)

Entire sentences can be produced by combining a productive form in one hand with another in the other hand. For example, for the meaning 'the

cat is on the table' in Figure 10, in the last sign, the dominant hand handshape indicates 'a small animal' and the hand location shows 'is located on'. The handshape in the non-dominant hand indicates 'a flat horizontal surface' and the spatial arrangement of the hands conveys the relative locations of the objects. The handshapes in these productive signs of movement and location act like proforms and are usually identified (before or after) with their specific referent (for the example here, conventional signs for 'cat' and for 'table'). This sentence also illustrates the convention for mentioning the larger object first.

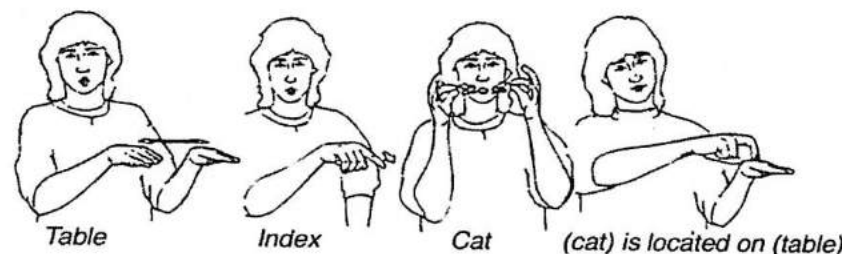


Figure 10. Productive signs used to sign 'the cat is on the table' in Swiss German Sign Language (Boyes Braem 1995: 151)

Especially relevant for methodology is the fact that not only is there a myriad of possible productive forms but that, in addition, they have no single 'citation' form. One cannot, for example, make the productive locative verb meaning 'to be located' in Figure 10 without producing some kind of handshape, which automatically specifies a class of referent.

For lexicographers, the large number of productive signs having no citation form combined with their manifestations in tokens which often involve gradient features, make them very difficult to represent in signed language dictionaries. As a result, almost all sign language lexica produced to date consist of the 'conventionalized' (or 'frozen') lexicalized items that have citation forms, which can be described by non-gradient, componential features and make little or no mention of productive forms.

Unlike lexicographers, researchers working with signed texts or corpora cannot just leave out these productive forms, as they are omnipresent in actual signing. The exact proportion of productive to conventional signs in a text depends to some extent on the type of discourse. Research on French Sign Language has found that up to 70% of signs in some narrative styles were productive signs (Sallandre 2003, cited in Pizzuto et al. 2006). Konrad (2011) found in four dictionaries for technical terms in German Sign Language, that productive forms represented 25% of the total tokens.

How these productive forms are represented in transcripts of signed text has depended on the individual researcher and the aims of the transcription. Figure 11 shows how productive forms were represented in advanced level learning material for Swiss German Sign Language (DSGS). Here, productive verbs of movement or location are represented with an abbreviation: Sbw (*sich bewegen*) for verbs of locomotion and Sbf (*sich befinden*) for verbs of location. Additional comments are appended in parentheses to give some indication of the complete meaning of these complex signs. The last sentence of story transcribed here is typical of spontaneous narratives with an abundance of productive signs, here shown in bold type.

Sbw(Doppeldecker) Rolle: Roter Baron [ZIELEN FB(Kreise)
 FB(Kühlerfigur) ZIELEN Sbw(Propeller) ZIELEN HH(steuern)
 Sbw(Geschosse beidseitig abfeuern) Rolle: Pilot [«hört Geschosse»
 Sbw(Geschosse auf Flügel) | FB(Flugzeugkörper) Sbw(Objekt in den
 Flugzeugkörper) Sbw(Objekt fliegt von Flugzeug weg) Sbw(Geschosse
 beidseitig abfeuern) Rolle: Sbw (Flugzeug kippt) Sbw(Flugzeug Roter
 Baron) Sbw(Doppeldecker) Rolle: Roter Baron [schaut nach unten
 FLUGZEUG_2 RAUCH] Sbw(Flugzeug stürzt zu Boden) Sbw(viel Rauch) ||

Figure 11. The last sentence of a gloss transcription of a Swiss German Sign Language narrative about The Red Baron in which productive forms are marked here in bold type. The productive forms are verbs of movement (Sbw, *sich bewegen*), of location (Sbf, *sich befinden*) and form descriptions (FB, *Form Beschreibung*) with additional descriptions in parentheses (Boyes Braem 2005b)

7.3. Representing iconicity in a separate gloss ('double glossing')

Researchers at the University of Hamburg have attempted to address the issue of iconicity at the lexical and text levels by the use of a system of 'double glossing' (Konrad 2011). This methodology evolved from earlier theories of iconicity used by Cuxac to describe French Sign Language (*Langue des Signes Français*, LIS; see, for example, Cuxac and Sallandre 2007). In addition to the traditional gloss reflecting the sign's meaning (as described in Section 4.1), each sign is given a more basic gloss that reflects the sign's underlying iconic image. An example of an iconic gloss in the German data is FLACH1A for the image of something horizontal and flat. It is made with the hand held palm down, fingers outstretched but not spread. FLACH1A is associated with the meaning and forms of 16 conventional signs in the current DGS lexica for technical terms (Basis, Boden,

Bühne, Erdgeschoss, Feld, Fläche, Fußboden, Grund, Grundlage, Land, Platte, Platz, Prinzip, Pult, Teppich, Tisch) (Konrad 2011: 139).

An important part of the methodology of double glossing is that iconicity is treated as a central feature not only of productive vocabulary but also of most conventional signs. According to Konrad (2011), the inclusion of iconicity in the identification of lexical units shows the structuring function of iconicity at the lexical level, and thus is something, which should be clear also in the lexical description of all forms of the vocabulary (Konrad 2011).

The recognition of underlying iconic forms in the conventionalized vocabulary also provides a way of addressing something often seen in signed language corpora, the 're-iconization' of conventionalized signs. Brennan (1990b), who was one of the first to use the term 're-iconization', writes in her analyses of British Sign Language (BSL) that clearly the relationship between sign form and meaning in many examples is often motivated, and hence not purely arbitrary. She goes on to suggest "this motivated relationship has a 'triggering' effect in the production of new signs" (Brennan 1990b: 217). Similar findings were made in other studies, including an analysis of new signs created for technical terminology in Swiss German Sign Language (Boyes Braem et al. 2012). The inherent, 'sleeping', iconicity of signs is also an aspect of the creation of signed language poetry (Sutton-Spence 2005).

In sum, this form of double glossing offers researchers working on signed language texts a unified way of representing both conventionalized (and potentially re-iconizable) as well as more obviously iconic productive forms in their signed corpora. The representation of the underlying iconic form also means that relationships between lexical items can be identified not only according to semantic families (as in written language glosses), or according to formal elements (as in HamNoSys and SignWriting notations), but also according to networks of shared underlying iconic forms. This represents a step away from the previously used lexical models, that had been heavily influenced by descriptions of oral languages, and is a step towards linguistic analyses that are potentially more insightful about this visually-based language. Konrad writes that the underlying iconic gloss reflects what Deaf signers have long observed informally:

The analysis of the basic underlying picture is the making-explicit of a knowledge that Deaf unconsciously are constantly reactivating when they use conventional signs as contextualizing methods for mouthings, to modify signs and to re-iconize or produce new productive signs. (Konrad 2011: 214, translated from German by the author)

8. Concluding thoughts

Each of the methods described here for written representations of signs has its own advantages and disadvantages, which are summarized in Table 1 below.

Table 1. Overview of possibilities of written representation of isolated signs and signs in sentences/discourse (HNS: Hamburg Notation System; SW: Sign Writing, Iconic gloss: Hamburg's double glossing system; BTS: Berkeley Transcription System; Elan: Media Tagging program; iLex: Media Tagging program+lexicon)

		HNS	SW	Gloss	'iconic' Gloss	BTS	Elan	iLex
Isolated sign	represented with symbols	✓	✓					
	represented with written oral language (ol)			✓	✓	✓		
	reproducible from written form alone	✓	✓					
	represents iconic elements in conventional and productive forms		✓		✓			
Signs in sentences/text	Multi-dimensional spatial and non-manual components represented with		✓ symbols as images	✓ ol words	✓ ol words	✓ ol words	✓ ol words or notation symbols in separate tiers	✓ ol words or notation symbols in separate tiers
	easily readable		✓	✓	✓	✓	✓	✓
	reproducible from written representation alone		✓					
	machine writable and searchable	✓		✓	✓	✓	✓	✓

At the present time, a truly adequate written representation of signed language, especially signed language texts in corpora, would involve a combination of different methodologies, for example:

- SignWriting notation of the sign token, as its symbols offer the most complete representation of signs in context, and is readable and reproducible from the symbols alone;
- HamNoSys notation in order to be able to machine search at least the basic manual, if not yet all the non-manual components of the signs;
- Machine searchable and easily readable ID-glosses to represent the sign lemma, linked to a central lexicon and video-archive, providing glossing consistency and further information about the form, meaning and variations of the sign;
- An additional gloss of the sign's underlying iconic form;
- Additional tiers for non-manual components of the face, mouth, upper body and eye gaze needed especially to annotate specific morpho-syntactic syntactic, discourse and prosodic features.

Other linguistic annotations could be added in additional tiers, depending on the specific aims of the research. For example, Berkeley morpheme notation (BTS), annotations for word class, constructed speech or action, turn-taking. A tier with translation of entire sequences into the written form of an oral language would make searches for content topics much easier. Whenever possible, the annotations should conform to the agreements for shared standards for annotations that were the outcome of the Sign Language Corpus Network's third workshop (http://www.ru.nl/slcw/workshops/3_annotation/). Future international collaboration in the development and (equally important) actual use of such conventions might also lead to a future IPS-kind of phonetic notation for all sign languages, perhaps based on the HamNoSys system. (Another first attempt at developing an IPA system is the Sign Language International Phonetic Alphabet, SLIPA by Peterson, available online at <http://dedalvs.com/slipa.html>.)

A final thought: Signed languages are, of course, not the only kind of data, which have proven difficult to represent in written forms. In the field of electro-acoustic music, for example, there are no scores. Bennett (1997) points out the consequences:

Not only is it next to impossible to speak seriously about the craft of composition without a literature which can be analyzed, it is equally difficult to do any kind of serious aesthetic education. Without models one can examine soberly, away from the bright lights of performance... it is difficult to isolate, let alone to formulate arguments for and against, particular aesthetic decisions. (Bennett 1997: 11, translation from French by Bennett)

Bennett goes on to note that, although this lack of written form has the pedagogical effect of making it difficult to pass on to students knowledge about electro-acoustic music, it doesn't, of course, stop the composer from 'writing' computer music. In contrast, the analogous problem of written forms for signed languages, especially for signed texts, presents a serious obstacle for linguists. Not only, as Crystal (1987: 381) has also pointed out, that the teaching and training of future generations of researchers is dependent upon written forms of the data, but also, to paraphrase Bennett, linguists need to 'isolate and analyze elements, formulate arguments for and against theoretical descriptions, theories and models of the language'. However, the combination of existing writing systems with evolving technologies and theories offers the linguist today more hope than ever for adequate and useable written representations of signed languages.

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