

Natural Sign Languages

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It has been nearly forty years since serious investigation of natural sign languages began to show that these languages are bona fide linguistic systems, with structures and rules and the full range of expressive power that characterize spoken languages. Researchers have spent most of that time demonstrating, with increasing rigor and formality, the sometimes surprising similarities between languages in the two modalities, spoken and signed. Concomitantly, scholars in the related disciplines of language acquisition and neurolinguistics have been discovering significant similarities between spoken and signed languages in these domains as well. It is safe to say that the academic world is now convinced that sign languages are real languages in every sense of the term.

If this were the whole story, however, there would be no need for a chapter on sign languages in this volume. Each sign language would be seen as a language like any other, English, Hungarian, Central Alaskan Yupik Eskimo, or Mandarin Chinese, each with its own contribution to make toward understanding the general language faculty of humans. But this is not the whole story. Rather, sign languages as a group are of special importance, crucial to our understanding of the essential nature of language, for two reasons. First, the study of natural languages in a different physical modality confirms in a novel way the hypothesis that all natural human languages are characterized by certain nontrivial and identifiable properties. And second, this study raises fundamental questions about the human language capacity, as well as challenges for language theory, that we would never have noticed were it not for the existence of sign languages.

Sign language research has already made a significant contribution to our understanding of human language -- its structure; its acquisition by children; its representation in the brain; and its extension beyond communication, in poetry -- all of which we survey in this chapter. But the survey would be incomplete without considering the **potential** contribution to be made by the investigation of sign languages in the future. Most importantly, we expect future studies to allow researchers to delve into the second issue we've mentioned above -- questions and challenges for the theory of human language that sign languages bring to the fore. For example, it appears that, while the individual structural properties of sign languages are attested in spoken languages, no spoken language has the same **clustering** of properties that characterizes sign languages. Furthermore, despite the fact that vocabularies differ from sign language to sign language, their grammatical **structures** seem to be remarkably similar to each other. Recent neurological studies of the language-brain map indicate some differences in brain mediation of spoken and signed languages, posing another challenge. Developing an explanation for these observations will require language theorists to move well beyond the ideas generated by the study of spoken language alone.

The sign languages under discussion are the languages used by communities of deaf people all over the world. They are natural languages, in the sense that they are not consciously invented by anyone, but rather develop spontaneously wherever deaf

people have an opportunity to congregate and communicate regularly with each other. Sign languages are not derived from spoken languages; they have their own independent vocabularies and their own grammatical structures. Although there do exist contrived sign systems that are based on spoken languages (such as Signed English, Signed Hebrew, etc.), such systems are not natural languages, and they are not the object of interest here. Rather, linguists and cognitive psychologists are interested in the natural sign languages passed down without instruction from one deaf generation to the next, and used by deaf people in their own communities all over the world.

Sign languages exhibit the full range of expression that spoken languages afford their users. Different styles are adopted for different social contexts; story-telling has been heightened to an art in some deaf communities; deaf poets create artistic poetry in signs, marshalling the formational elements of the languages to convey images, emotions, and ideas. Sign language can "do" everything that spoken language can. We now turn to an examination of how it does so.¹

1. Linguistic Structure of Sign Languages.

We begin by offering a sketch of the evidence that sign languages have grammatical structures comparable to those of spoken languages.² We begin with the structure of the sentence (syntax), and move to the structure of the smaller units of language, those that may be compared to the meaningless but identifiable sounds of speech (phonology). We will end this section with a discussion of the structure of words (morphology).³

1.1. Sentence structure: Syntax.

One of the fundamental properties of human language is that it can be used to create an unlimited number of utterances given a limited number of pieces. At the syntactic level, this property follows directly from a mathematical property of language called recursiveness. We're all familiar with recursiveness (even if not with the term). It is found in language, and computer programs, and even in children's stories, as in (1).

¹ This article is a distillation of the work of many researchers, whose work we often do not cite specifically. The references we include are of two types: (a) works that are accessible to a general audience, and (b), for linguists, survey articles or books with detailed bibliographies.

² Most but not all of our evidence comes from American Sign Language (ASL), since it is the most-studied sign language to date. ASL is about 200 years old, and it is used by deaf people in the United States, much of Canada, and parts of Africa.

³ We have selected linguistic characteristics that are general and simple, to make our point. However, many other, more formal and more complex characteristics have been found to be common to languages in the two modalities as well. Sandler and Lillo-Martin (in preparation) provides an overview of theoretical linguistic research on sign languages.

- (1) This is the farmer sowing the corn,
That kept the cock that crowed in the morn,
That waked the priest all shaven and shorn,
That married the man all tattered and torn,
That kissed the maiden all forlorn,
That milked the cow with the crumpled horn,
That tossed the dog,
That worried the cat,
That killed the rat,
That ate the malt
That lay in the house that Jack built.

In (1), the process or rule that creates a relative clause (here, the clauses beginning with *that*) has applied repeatedly to the noun phrases inside other relative clauses. This repeated application of the same rule to create more and more complex sentences is an example of recursiveness. The children's story is amusing precisely because we all know that there is no theoretical limit to the application of this rule. Any speaker of English can add to the story by generating another relative clause at the beginning, as in (2).

- (2) This is the banker, his honor forsworn
That foreclosed on the farmer sowing the corn.....,

The only limitations on the number of relative clauses are practical and not linguistic: the speaker may run out of things to say, or out of breath, or time, or memory. It is because the rules of syntax are allowed to apply recursively that language is non-finite: there is no limit to its expressive power. It is important that this recursiveness applies to create structures which are **embedded** inside other structures, to create subordinate clauses, such as the *that* relative clauses in (2). These embedded subordinate clauses involve more complex structure than coordinate clauses, which are illustrated in (3).

- (3) This is the dog, and the dog worried the cat, and the cat killed the rat, and the rat ate the malt, and the malt lay in the house and Jack built the house.

Embedding distinguishes subordinate clauses of the sort exemplified by *The House that Jack Built* from simple coordination. A simplified diagram of the structure of recursive subordinate versus coordinate clauses is given in Figure 1. The rule that makes a relative clause -- put a sentence inside a noun phrase -- produces a structure in which one sentence is inside another sentence. This is the key to recursion: by putting one phrase inside another of the same type, there is in principle no limit to the length of a sentence.

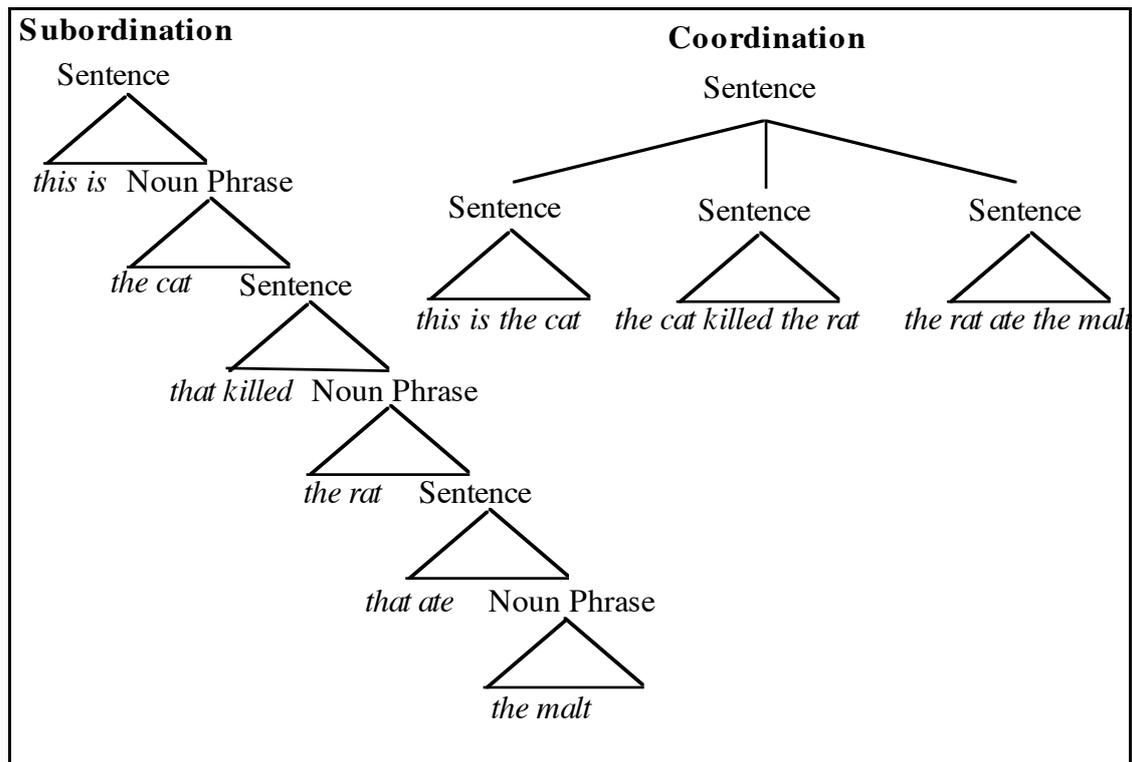


Figure 1. Simplified phrase structure diagrams of subordination and coordination

Human language is not limited to simple conjunction of one phrase after another (like that in (3)); it has both coordination and subordination. If someone found a human language that allowed only coordination, not subordination, this would shake our fundamental assumptions about what human language is. Thus, it should be rather surprising that exactly this was claimed about ASL in the early days of its study. Thompson (1977) attempted to discover the mechanisms for subordination in ASL, and, not finding what he considered to be evidence for it, decided that it was systematically missing. If this is correct, then either the character and structure of human language is not as has been commonly assumed, or signed languages are significantly different from spoken languages, missing recursivity, which is often taken to be a defining property of language.

Later research has made it unnecessary to choose between these two puzzling options. Liddell (1980) argued convincingly that Thompson's claim was incorrect, and Liddell's analysis has been substantiated by many researchers since.

Thompson had looked for several kinds of indications that ASL has subordination. For example, he looked for overt complementizers - an analogue to English *that* in 'I know that Susan will win' - and found none in ASL. He looked for relative clauses (like those in (1-2)) - and instead found sequences of signs as in (4).⁴

⁴ We follow the convention of using upper case English words to represent signs. 'IND' stands for 'index, a pointing gesture.

- (4) English Target: The girl Asa gave the dog to is pretty.
ASL response: ASA GIVE DOG GIRL IND PRETTY IND
[roughly: Asa gave the dog to the girl and she is pretty.]

He looked for clausal complements to adjectives like ‘happy’ (cf. ‘He’s happy that she passed.’) and found instead unembedded sequences, as in (5).

- (5) English Target: I regret that Asa had to leave.
ASL response: MUST ASA MUST GO / SORRY
[roughly: Asa must go. I’m sorry.]

In some ways, these and other observations of Thompson’s were correct. However, his conclusion that ASL had no grammatical means of embedding to create subordinate clauses was shown to be wrong. Liddell noticed that relative clauses are indeed grammatically marked in ASL, contrary to Thompson’s claims -- not by function words such as *that*, but by **non-manual** grammatical markers.

Liddell identified the non-manual marker of relative clauses as consisting of raised brows, a backward head tilt, and a tensed upper lip. This non-manual marker co-occurs with the material of the relative clause. In addition, Liddell argued that relative clauses in ASL are not like those of English. In particular, he showed that the noun that is modified by the relative clause occurs inside the clause in ASL, as in spoken languages like Diegueño, rather than outside it as in English. While in English the subordinating word *that* indicates a relative clause, in ASL the nonmanual markers that extend over the clause perform essentially the same role. A comparison of these aspects of relative clauses in ASL and English can be observed in (6).

- (6) a. English relative clause: modified noun (underlined) outside the relative clause; relative marker *that*
The dog that chased the cat came home.
- b. ASL relative clause: modified noun (underlined) inside the relative clause; nonmanual relative marker, ‘rc’.

rc
RECENTLY aDOG CHASE bCAT aCOME HOME.

In the notation, the line marked ‘rc’ indicates the scope of the relative clause non-manual marker. The lower case subscripts are indices for DOG and CAT. The ‘a’ index on DOG and COME are expressed formationally in the language, indicating that it was the dog and not the cat that came home.

Clearly, the reason why Thompson thought ASL has no relative clauses was that he expected them to look more like English. However, once the characteristics of relative clauses in languages other than English are considered, it becomes clear that ASL does have relative clauses, formed by a rule of subordination that allows recursion.

Since Liddell’s counterarguments to these and other claims of Thompson’s appeared, other researchers have provided additional evidence for subordination in

ASL (see especially Chapter 3 in Padden, 1988), which provides syntactic tests that differentiate embedded from main clauses), and all current work assumes it.

A controversy over word order properties in ASL was similarly resolved by more careful analysis, and by looking beyond English. Since basic word order is very flexible in ASL, some early researchers argued that only pragmatic considerations, such as emphasis of some part of the sentence, and not linguistic structure, dictate word order in ASL sentences -- that there are no syntactic rules for ordering words. However, since then, many researchers have collected evidence to support the point of view that ASL -- like Japanese, Russian, and other spoken languages which allow for relative flexibility in surface word order -- has an underlying structure and word order (in the case of ASL, Subject-Verb-Object), which can be modified by rules of the grammar. Here too, most researchers now assume the basic order argued for in these works, and current work concentrates on the rules and principles which generate this order and its many variants.

Using the tools of linguistic analysis, it is possible to go much beyond the observation that ASL has recursion and subordination and a basic word order. Of crucial concern is whether or not ASL adheres to constraints hypothesized by proponents of the Universal Grammar Hypothesis to characterize all languages. According to this hypothesis, the decisive constraints are those which are found to be operative across languages, but for which overt evidence in the linguistic environment does not seem to be available. If some knowledge which adults are shown to possess is not accessible to the language learner, it is hypothesized to be in some sense part of the innately determined universal human language capacity. For example, consider the paradigm in (7).

- (7) a. Steve likes beer with pizza.
b. What does Steve like beer with?
c. Yoav likes wine and cheese.
d. *What does Yoav like wine and?

Although the relationship between (7a) and (7b) is very similar to the relationship between (7c) and (7d), only the first pair are both grammatical. Making a question out of the noun phrase following a preposition is (usually) grammatical in (colloquial) English, but making a question out of a noun phrase which is coordinated with another noun phrase is not. In fact, the restriction on questions like (7d), which disallows extraction of material out of a coordinated structure, is virtually universal, and it has been proposed that a general universal constraint -- the Coordinate Structure Constraint -- prohibits it.

Whether or not one accepts the hypothesis that such constraints are innately specified, the fact that they are not easily deducible from the input but appear to be ubiquitous in spoken languages makes them key exemplars of the human language capacity. It is therefore important to determine whether or not they hold for sign languages as well. If so, we may conclude that the constraints are truly universal, and that sign languages have the same properties as any other natural language. In fact, several researchers have argued that this is the case.

The Coordinate Structure Constraint demonstrated in (7) provides the clearest example. Padden (1988) shows that coordinate structures are allowed in ASL, as illustrated in (8).

- (8) _iINDEX _iGIVE₁ MONEY, _jINDEX _jGIVE₁ FLOWERS
 “He gave me money but she gave me flowers.”

Furthermore, as expected, ASL, like English, clearly prohibits violations of the Coordinate Structure Constraint, as illustrated in (9). The ‘t’ on the line over FLOWER in (9) indicates a nonmanual marker for topicalization, the process by which the topic, FLOWER, is extracted and moved out of the coordinated structure, to the beginning of the sentence.

- (9) $\overline{\quad\quad\quad t}$
 *FLOWER, ₂GIVE₁ MONEY, _jGIVE₁
 “Flowers, he gave me money but she gave me.”

In several domains of syntax, the constraints proposed to be universal (including the Coordinate Structure Constraint) can be demonstrated to apply to ASL as well as to spoken languages -- and it is expected that other signed languages will also show adherence to these constraints.

1.2. The structure of sounds and their sign language equivalents: Phonology

In order to have sentences, one must have words, and words -- at least in spoken language -- are pronounced as a series of sounds. What about the sign of sign language? Does it have a level of substructure like the spoken word? Since spoken and signed languages are produced and perceived by different physical systems -- oral/aural, and manual/visual -- one might expect to find the least amount of similarity across the two modalities at this level of analysis. Yet, here, too, there is much common ground.

In 1960, William Stokoe published a monograph in which he demonstrated that the words of American Sign Language are not holistic gestures, but rather are analyzable as a combination of three meaningless yet linguistically significant categories: handshapes, locations, and movements. That is, by changing some feature of any one of those three categories, themselves meaningless, one could change the meaning of the sign. For example, by changing only the configuration of the hand, the signs DECIDE and PERSON are distinguished. In these two signs, the locations and movements are the same. Only the hand configuration is different. Similar pairs exist that are distinguished only by their locations or only by their movements.

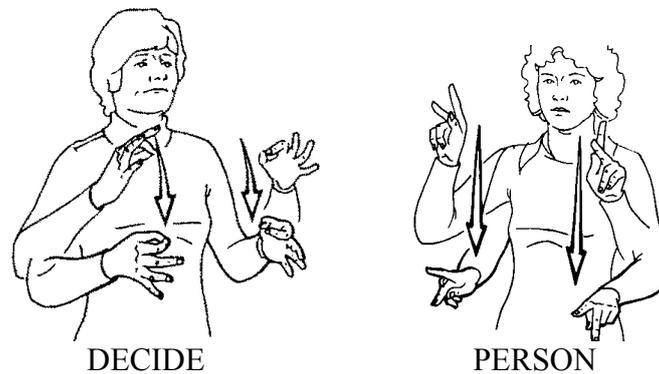


Figure 2: ASL

The example in Figure 2. is analogous to the English pair, *pan*, *tan*, in which the first sound of each word -- *p* and *t* -- is different. The sounds are themselves meaningless, but they are linguistically significant because they make a difference in meaning when put in a word. In the sign language pair, DECIDE, PERSON, the hand configurations are also meaningless, yet they too make a difference in meaning. The other formational elements -- locations and movements -- can, like hand configurations, independently make a difference in meaning, though they are themselves meaningless.

This finding was of supreme importance. Ever since its discovery, it has no longer been possible to assume, as most people previously had, that signs are fundamentally different from spoken words, that they are simple iconic gestures with no substructure. Rather, Stokoe showed that ASL is characterized by a defining feature of language in general: duality of patterning. This duality is between the meaningful level (consisting of morphemes, words, phrases, sentences), and the meaningless level, which in spoken languages is the level of the sounds that make up the meaningful expressions. The meaningless elements of spoken language are linguistically significant (i.e., they discretely influence meaning); they obey constraints on their combination within morphemes and words; and they may be systematically altered in different contexts. This is the domain of phonology. The list of handshapes, locations, and movements are the formational elements of sign language phonology, comparable to the list of consonants and vowels in spoken language. We will now show that sign language phonology is also characterized by constraints on the combination of these elements, and by systematic changes in 'pronunciation' according to context.

All languages have constraints on the cooccurrence of sounds in syllables and words. For example, English does not allow the sequences **sr* or **chl* at the beginning of a syllable or word (although other languages do permit such combinations). Sign languages as well have constraints on the combination of elements at this same level of structure. For example, only one group of fingers may characterize the handshape within any sign. While either the finger group 5 (all fingers) or the group V (index plus middle finger) may occur in a sign, a sequence of the two shapes, **5-V* is prohibited in the native signs of ASL and other sign languages.

Similarly, all languages have assimilation processes, in which sounds borrow some or all aspects of neighboring sounds. For example, in the English compound

words, *greenback* and *beanbag*, the nasal sound [n] often assimilates the labial place of articulation from the [b] that follows it: *gree[m]back*, *bea[m]bag*. In many common ASL compounds, part of the hand configuration may similarly assimilate from one part of the compound to the other. The example here is from the compound which means OVERSLEEP, made from the two words SLEEP and SUNRISE. Just as the [n] borrowed one of the features of [b] (the bilabial feature) in the English example above, in the ASL compound, the hand configuration of SLEEP borrows a feature from the following sign in the compound, SUNRISE. It borrows the orientation feature. That is, rather than being oriented toward the face as in the citation form of SLEEP, the dominant, signing hand in the compound OVERSLEEP is oriented sideways, as in the sign, SUNRISE.

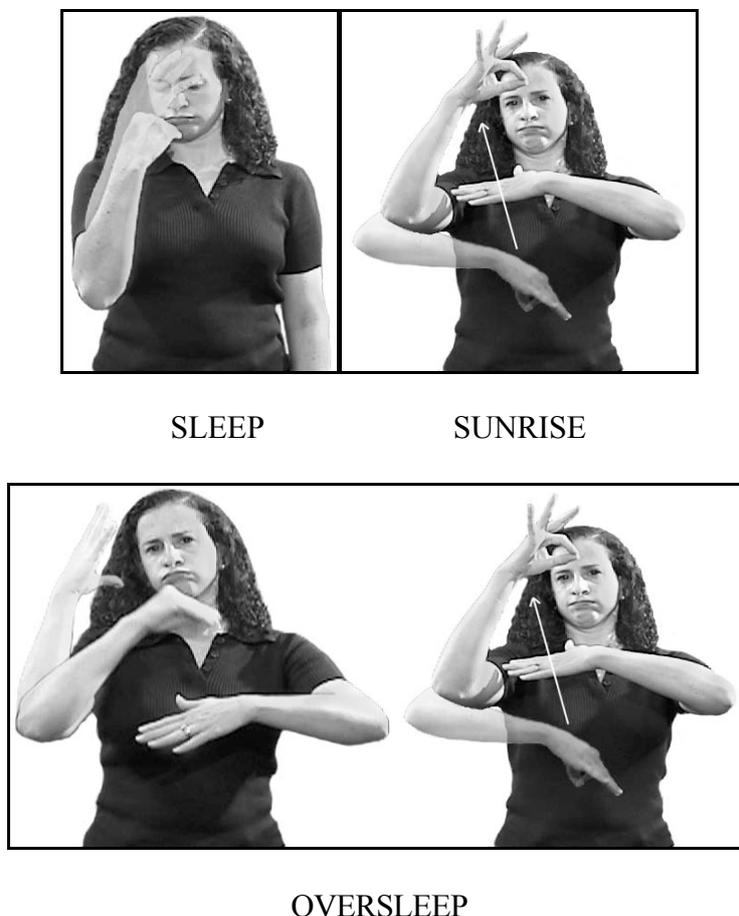


Figure 3. ASL signs SLEEP and SUNRISE, and the compound OVERSLEEP with orientation assimilation

An aspect of language structure that involves both phonology and syntax is prosody. Prosody involves rhythm, to separate the parts of a sentence; prominence, to emphasize selected elements; and intonation, to communicate other important information, such as the discourse function of the sentence, e.g., whether an utterance is a plain declarative sentence or a question. Recent work argues that sign languages have the equivalent of prosody. While spoken languages use the rise and fall of the pitch of the voice, volume, and pause to achieve these effects, sign languages employ

facial expressions, body postures, and rhythmic devices in similar ways and for similar functions.⁵ Examples are the Israeli Sign Language facial expressions for yes/no questions, and for information assumed to be shared by the signer and addressee⁶, shown in Figure 4.

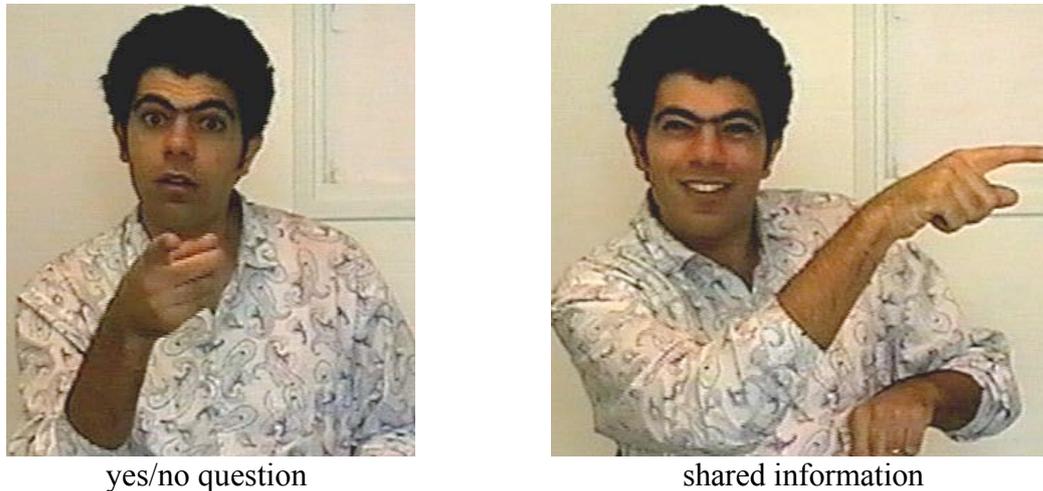


Figure 4. ISL Y/N question and 'shared information' facial expressions

Sign language facial 'intonation' is **different** from the facial expressions used by hearing people in their communication, which are random, affective, and optional. Rather, sign language facial expressions are like the intonational pitch patterns of spoken language. Both tonal melodies and facial melodies are **grammaticalized**, i.e., fixed and systematic. For example, the intonational melody used in spoken language to ask a question requiring an answer of 'yes' or 'no' is systematically different from the one used to make a declarative statement. The same is true of the facial intonations for these two types of sentences in sign language.

In the next subsection, what is perhaps the most central aspect of language is examined: the word.

1.3. Word structure: Morphology

Most languages have both simple words, such as *teach*, and complex words, such as *teach+er*. Knowing English entails understanding the internal structure of its complex words, as well as the ability to create and understand new complex words that exploit those same kinds of internal structures. The study of the internal structure of words is called morphology.

For example, given a new verb *scaff*, as in *The purpose of this machine is to scaff computers against viruses*, we can also create or analyze the internal structure of the word *scaff* and can deduce something about its meaning in the sentence, *The company purchased several expensive scaffers last year*. We would also immediately

⁵ There is a significant body of literature on nonmanuals as syntactic markers in ASL -- along the lines of Liddell's analysis of relative clauses shown in section 1.1, example 6b. In the interest of space, we only mention the prosodic treatments of such markers here.

⁶ Both yes/no questions and shared information are signalled by intonation in English as well.

judge the nonce word **er+scaff* to be impossible in English. Speakers of English know the form and function of the meaningful word component-*er*, and they know that it is a suffix rather than a prefix. Although users of a language are usually not conscious of their linguistic knowledge, their use of language clearly reveals the existence of this underlying system.

Another type of complex word formation can be thought of as relating words to each other within a sentence. For example, the word *walk* has two different suffixes in the following sentences, *-s*, and *-ed*. The *-s* in sentence (10) is an agreement marker; it shows that the subject of the sentence, *Hadar*, is third person singular ('he' or 'she'). The *-ed* in sentence (11) is a tense marker, showing that the event described by the sentence took place in the past.

(10) Hadar walks to school sometimes.

(11) Stephanie walked to her friend's house.

The existence of complexity of structure within words is a typical property of spoken language, though many different kinds of word formation can be found in the languages of the world. Most languages have complex words, and many languages have far more complex morphology than English has.⁷

What about sign languages? While one might expect any communication system to have syntax, one might not necessarily expect sign languages to have internal structure to their words. Rather, one might expect, as naive early descriptions of sign language used to claim, that signs are holistic gestures, each one representing a unitary concept. Concomitant with this view is the belief that the vocabulary of sign languages is purely iconic, that there is a one-to-one relationship between the form of a word or concept and its meaning. The ASL sign for AIRPLANE looks something like an airplane; the sign for GIVE looks something like the act of handing something to someone. If these sign words are iconic wholes, then adding grammatical complexity to them in a systematic way might seem counterintuitive.

Yet sign languages do have a great deal of morphological complexity. Such complexity is one of many sources of evidence that systematic grammatical structuring strongly dominates the presumably iconic origins of these languages. We will describe two kinds of word complexity here: verb agreement and verbs of motion and location.

We begin with verb agreement. In many spoken languages, verbs have some kind of marking on them that gives information about their subjects, objects, or other nouns directly related to them in the sentence. Example (10) above shows the only agreement marker that English has on main verbs, the *-s* which indicates third person and singular in the present tense. Other languages have far richer agreement systems. For example, Swahili has both subject and object agreement markers that indicate person ('I', 'you', 's/he'), gender ('he' or 'she'), and number (singular or plural):

⁷ There are a few spoken languages, such as Vietnamese, that do not have complex words, which shows that morphological complexity, while extremely widespread, is not a universal property of language.

(12) a - ta - ku - penda
 he (subj) future you (obj) like
atakupenda - 'he will like you'

(13) u - ta - m - penda
 you (subj) future him (object) like
utampenda 'you will like him'

All sign languages investigated so far show a comparable kind of verb agreement. Consider for example the Israeli Sign Language verb *SHOW*, shown in Figure 5. To say 'I show you', the motion of the sign is from a point near the signer toward the addressee. To say 'you show me', the beginning and endpoints of the sign are just the opposite, beginning at a point near the addressee, and ending near the signer. The beginning and endpoints of the sign are markers for the subject and object of the verb it represents. To say, 'I show you (plural)', the hands moves in a horizontal arc in front of the signer.

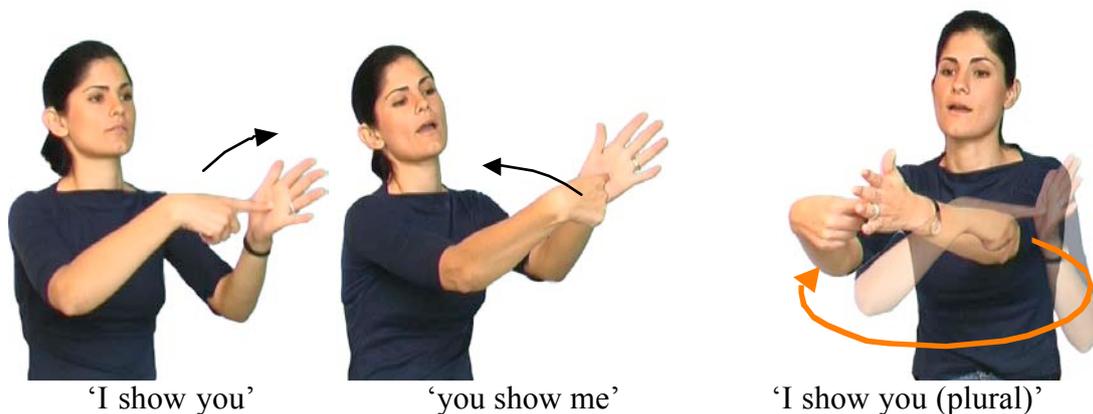


Figure 5. ISL verb agreement

In the first example, 'I show you', the first position of the hand corresponds to the prefix *a* in the Swahili example in (11) above: it marks agreement with the person of the verb's subject -- third person ('he') in the Swahili example, and first person ('I') in the ISL example. The second position of the hand corresponds to the morpheme *ku* in the same Swahili example, agreeing with the person of the object of the verb -- second person ('you') in Swahili, and second person also in ISL. The beginning and endpoints of the second example in Figure 5 similarly mark agreement with subject and object -- here, 'you' and 'me'. To agree with the second person plural -- 'I show you (plural)', the shape of the movement is altered.

This kind of phenomenon can be described as subject-object agreement; in particular, sign language verbs agree for person and number of their subject and object. In this way, the verb agreement found in sign languages is similar to that in many spoken languages.

A characteristic of verb agreement systems in sign languages is that different categories of verbs participate in this system in different ways. For example, in addition to the subject-object agreement described earlier, some verbs, commonly called backwards verbs, have the opposite agreement pattern of the one shown above. In these verbs, the movement of the hand is from the object to the subject, instead of the usual direction from subject to object. This class includes verbs such as INVITE, TAKE, COPY, ADOPT, essentially the same list in ASL and ISL, and possibly in all sign languages. Other verbs agree with points in space denoting specific locations, rather than with the verb's subject and object. Still others do not agree at all. We will have more to say about the peculiarities of sign language agreement and possible implications for language theory in section 3.

A more complex type of morphology in sign languages is found in verbs of motion and location, first described by T. Supalla (e.g., 1986). In these constructions, handshapes that stand for classes of nouns combine with types of movements and with locations in space. As such, these complex forms differ from the morphologically simple signs of the language exemplified in the phonology subsection above.

As an aid to interpreting these forms, which have no analog in English, let us consider some words in the native American language, Navaho. This language incorporates into the stems of verbs of motion and location the shape and dimensionality of associated objects, as shown in the following examples.⁸ The hyphens show that what are separate words in English are not independent words in these other languages. Rather they are morphemes, like *-er* in English, which combine with words or parts of words to form a new, complex word.

(12) Navaho

- a. beeso si-?a
 money be-located-of-round-entity
 'A coin is lying (there).'

- b. beeso si-ltsooz
 money be-located-of-flat-flexible-entity
 'A bill is lying (there).'

- c. beeso si-nil
 money be-located-of-collection
 'A pile of change is lying (there).'

⁸ An accessible description of this work, and the source of the examples of both ASL and Navaho in the present article, can be found in Newport (1981). The transcription shown here is simplified.

In these constructions, *beeso* means ‘money’ the prefix *si-* is a perfective marker, and the verb stems *?a*, *ltsooz*, and *nil* incorporate the shape and dimensionality of the entity involved.⁹

ASL (and other sign languages) has a comparable -- if potentially more complex -- system of verbs of motion and location. As in Navaho, each of the meaningful ASL morphemes is taken from a finite list that is determined by the lexicon and grammar of the language. In ASL, there is a list of noun ‘classifiers’, that represent semantic classes such as ‘small animals’, ‘humans’, or ‘vehicles’. Each of these classifiers is represented by a different handshape. Another type of classifier, also represented by different handshapes, specifies the size and shape of an object, such as ‘cylindrical objects’, ‘flat objects’, or ‘small round objects’. These handshapes may combine, in compliance with constraints of the grammar, with one of a short list of motion morphemes (e.g., ‘straight’, ‘pivot’), location morphemes, and manner of movement morphemes, each with a meaning of its own.

(13) ASL

- a. MONEY FLAT-ROUND-SHAPE-BE-LOCATED
“A coin is lying there.”
- b. MONEY FLAT-WIDE-SHAPE-BE-LOCATED
“A bill is lying there.”
- c. MONEY DOME-SHAPE-BE-LOCATED
“A pile of change is lying there.”

The following illustration exemplifies just the first of these. The shape of the hand is the morpheme meaning ‘small round object’. The short, downward motion means ‘be located’, and the location refers to a particular reference point in the discourse.



‘A coin is lying there.’

Figure 6. ASL verb of motion and location

It is very important to note that these forms are linguistic entities, i.e., morphologically complex words. They are neither pantomime nor otherwise strictly analogic to real world things and activities. Furthermore, this type of morphology,

⁹ We thank Keren Rice for explaining the Navaho data to us. The transcription and explanation presented here are simplified for clarity.

which incorporates nouns, verbs, and other lexical categories into single words, is not uncommon in the world's spoken languages. As we have seen, there are even spoken languages such as Navaho that incorporate into verbs the shape and dimensionality of associated nouns, as sign languages do.

Constructions of this sort in ASL can become far more complex than the example in Figure 6. For example, the two hands may each represent an independent classifier to create such forms as SMALL-FLAT-ROUND-OBJECT LYING-ON-FLAT-OBJECT ('A coin is lying on the table').¹⁰ Manner of movement morphemes can add still more complexity, forming, for example, expressions meaning roughly, SMALL-FLAT-ROUND-OBJECT-TRAVERSES-ARC-TO-ON-FLAT-OBJECT -- 'A coin flew in an arc shaped path, landing on the table'. Such forms are considered to be single words, though extremely complex ones.

All the ordinary words that make up the vocabulary of sign languages, words such as DECIDE and PERSON in Figure 2 in the previous subsection, are thus different from the verbs of motion and location described here. To understand this, compare DECIDE, repeated in Figure 7a. with ('A coin is lying there'), repeated in 7b. These two words are formationally very similar (except that DECIDE is two-handed), yet they are very different in their composition. FLAT-ROUND-SHAPE-BE-LOCATED ('A coin is lying there) is indeed decomposable: handshapes, locations, and movements each have meanings.

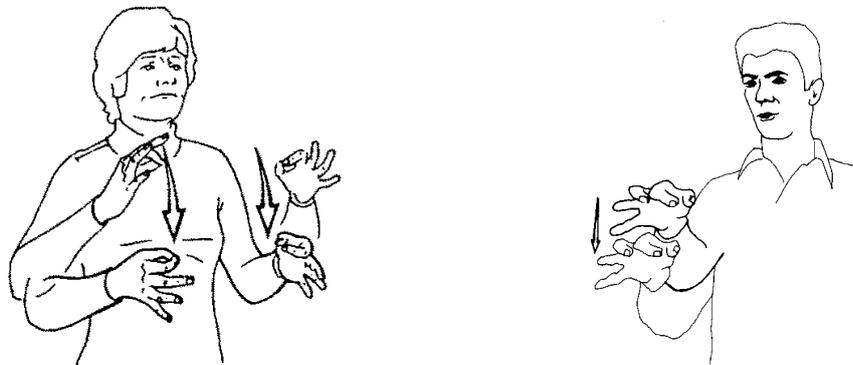


Figure 7. a. DECIDE b. FLAT-ROUND-SHAPE-BE-LOCATED

The properties we have described at each level of grammatical structure -- syntax, phonology, and morphology -- provide strong evidence that certain basic characteristics of language are indeed universal, belonging to language in either of the two natural modalities available to humans.

¹⁰ The particular word signified by the classifier -- *coin* and *table* in the example here -- is introduced into the discourse by a sign prior to the signing of the classifier construction.

2. Language as an art form: sign language poetry

Poetry takes language far beyond its primary task of everyday communication. By artfully manipulating the forms and meanings of language, the poet conveys a particular or heightened understanding of human experience. Devices such as meter, rhyme, and alliteration may filter the meaningful content of a poem, in order to create an impression or focus an image in the mind of the audience. A conventional meaning may be intentionally distorted in such a way as to enhance the perspective the poet wishes to present.

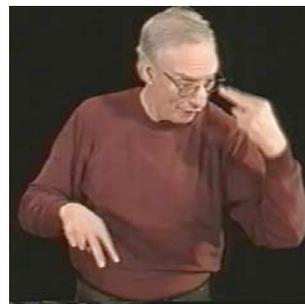
This union of language, culture, and art is found in some signing communities. We know of several accomplished deaf poets in The United States and Holland, and bring as an example of sign language poetry, some work of Wim Emmerik from Amsterdam.¹¹

Among the devices used by this poet are reiterative use of handshape, and a fluidity of style that results from the elimination of transitional movements. Entire poems may be characterized by one or two basic handshapes, such as the extended index finger handshape or the shape that extends all fingers. The aesthetic effect is similar to that of rhyme or alliteration in spoken poetry. While the movements that are part of signs are retained or modulated in some way, lines of poetry are skillfully constructed so as to omit the movements that result from the transition between the end of one sign and the beginning of another, creating flowing verse.¹²

The explicitly poetic, somewhat paradoxical device of disrupting or distorting conventional meanings in order to enhance the intended meaning is also recruited by Emmerik. In his poem, *Member of Parliament*, Emmerik presents a picture of the governmental representative as jaded and cut off from the occurrences and sensations of the real world. The closest that the member of parliament gets to events in his country is through reading the newspaper as he eats lunch. To convey the idea that the politician crudely ingests the news through his body, rather than experiencing events spiritually or intellectually, the poet portrays him **eating** the news. As he eats and reads, he alters the usual sign for *eat* (Figure 1) by changing its location to the eyes rather than the mouth (Figure 2). Intermittently, the member of parliament eats food and ingests news of the world.



‘eat’



‘eat with the eyes’

¹¹ We thank Daphna Erdinast-Vulcan for lending her literary expertise to this analysis of Wim Emmerik’s poetry.

¹² Both of these devices have been observed in American Sign Language poetry.

The value of the work of Emmerik and other deaf poets is first and foremost artistic. But the fact that poetry arises in established deaf communities is instructive as well. It teaches us that the desire and ability to mold the formational elements of language into an artistic expression of its content is a hallmark of human culture. It also shows clearly that sound is unnecessary, not only for communicative use of language, but for artistic use of language as well.

3. How is sign language acquired by children?

Current linguistic theory which hypothesizes that humans are genetically endowed with the fundamental underpinnings of language is supported by the claim that languages are similar to each other in significant ways. This view gains further support from the sign language findings reported in the previous sections. As we mentioned earlier, current theories are also based on the related observation that children acquire language automatically, including aspects of the system that do not seem directly retrievable from the input they receive. This section reviews phases of the acquisition of sign language, to see whether this process has the earmarks of automaticity and systematicity that are found in spoken language acquisition.

If sign languages represent the same cognitive system as spoken languages do, then they should be acquired in a similar way. If, on the other hand, the modality somehow prevents sign languages from belonging to the same cognitive system, then they may be acquired quite differently. Furthermore, if the acquisition of language represents the unfolding of a biological-cognitive program with innate components, then sign languages should be acquired at the same rate as spoken languages. Whether or not the underlying cognitive system is the same, the possibility exists that the modality - oral/aural or manual/visual - has an impact on the course of development. These issues form the context for sign language acquisition studies.

Numerous studies have examined the acquisition of sign languages by deaf children whose parents are deaf signers.¹³ Although this population represents only five to ten percent of deaf children, it is the relevant one to study because these children receive input in sign language from birth, just as hearing children receive input in their native language. In general, it has been found that deaf children who are exposed to sign language acquire it in very similar ways to the acquisition of spoken languages: they pass through the same milestones at the same rate.¹⁴

As one example, let us consider the child's first words or signs.¹⁵ Research on the acquisition of spoken languages finds that on the average, children begin to use their first words at around 11 months of age. The age varies from child to child, but

¹³ See Newport & Meier 1985, Meier 1991, and Lillo-Martin in press for reviews.

¹⁴ The process of language acquisition for deaf children with hearing parents depends on their linguistic input, which is quite varied. In some cases it might be a signed version of English, or in others, American Sign Language, or in many cases, spoken language input only (at least for the first several years of the child's life). Although there are many interesting properties of language acquisition in these differing sets of circumstances, we cannot go into them here.

¹⁵ See Newport and Meier (1990) for a thoughtful review of this research, on which this summary is based.

many studies across a variety of languages have converged on the same average age, so the acquisition of first words is often taken to be a milestone in language acquisition.

When do the first words of sign language appear? Some early studies claimed that deaf children begin to use their first signs around 6 to 8 months of age, much younger than the reported first words. Why would there be such a difference between first words and first signs? Two types of mutually compatible explanation have been proposed. One suggests that meaningful gestures are sometimes mistaken for signs, implying that there may not be a significant difference for all children, and the other assumes the difference is real, but offers a physiological explanation for the difference.

The first explanation points out that both deaf and hearing children make meaningful gestures during the time under consideration. If more stringent requirements are adopted for attributing 'word/sign' status to some production of the child, the difference between the first spoken words and the first signed words shrinks to about 1-1/2 months, or even disappears completely. Another possibility is that these first signs may be more easily recognizable by adult observers than first spoken words, due perhaps to iconic elements that stand out in communication contexts, or to the nature of visual perception. If this is correct, it would also point toward a smaller gap in the actual onset of first word production in the two modalities.

The second explanation considers the development of the articulatory mechanisms used for speech versus sign. Earlier maturation of the mechanisms for muscular coordination of the hands and arms over the vocal organs may make it easier for a child who is cognitively ready for first words/signs to produce a sign than a spoken word. Such explanations put the possible difference between the onset of signs and words in 'peripheral' mechanisms rather than the biological timetable for language. In other words, it may not be the case that signing is more advanced than speech, but rather that speech is delayed vis a vis sign. That is, children are cognitively ready to produce words before the coordination of the speech production system allows them to do so. This possibility is supported by evidence that (hearing) children comprehend words before they are able to produce them. The apparent discrepancy between the onset of first words in spoken versus signed language thus focuses important research questions that never would have even arisen if we considered only spoken language.¹⁶

The explanation offered by Newport and Meier is all the more reasonable when other areas of language acquisition are considered, where there does not appear to be a difference between sign and speech in the attainment of each milestone. For example, another important milestone of language acquisition, the use of two-word(/sign) combinations, seems to be attained at around 18 months for both signing and speaking children. Other later grammatical developments, such as the acquisition of verb agreement also follow parallel time courses across the modalities.

Let us consider another area in which the modality might be expected to have an impact on language acquisition: iconicity -- a direct correspondence between form

¹⁶ The purely motoric explanation may be oversimplified, however, since there is evidence that children's first spoken words are phonetically similar to their late babbling, and therefore do not represent a leap in coordination of the vocal apparatus. Other factors that make this issue difficult to evaluate is the small size of samples in some sign language studies. In any case, the research that has been conducted, partially summarized here, leads to interesting questions whose answers will be deeper and more accurate if both natural language modalities are taken into account.

and meaning. As should be clear from our discussion so far, signs have internal phonological and morphological structure, and are not merely 'pictures' of their referents. However, it is fair to say that some signs are iconically-based, in that there is a motivated (non-arbitrary) relationship between the sign and its denotation. Similarly, some aspects of the grammar may be thought of as iconic in origin. One might suppose that these iconic elements may aid in the acquisition of sign language, and in this way distinguish between the acquisition processes in signing and speaking children. What does the research show?

A clear example of iconicity comes from the signs for 'me' and 'you': these signs are made with pointing gestures which are essentially identical to the gestures made by hearing people when referring to first and second person, i.e., an index finger directed at one's self or at the addressee. Since the ASL signs are so iconic in this case, it might be expected that these signs would be particularly easy to learn, if the modality has an effect on language acquisition. However, it turns out that they are not.

For some hearing children learning a spoken language, it is found that for a short period in early language development, the terms 'me' and 'you' get mixed up: the child uses 'me' to refer to 'you', or 'you' to refer to 'me'. We can see why they might do this, since the referent for 'me' or 'you' changes depending on who is doing the talking. The child has to learn this peculiarity of these terms, and some children go through a stage of mixing them up. For the deaf child, since the forms used for ME and YOU are so transparent, it might be expected that no such errors would ever occur. However, some deaf children learning ASL make the same kind of mistake that some hearing children make: they confuse the signs for 'me' and 'you', despite their iconicity (Petitto 1987).

Studies involving other seemingly iconic aspects of the grammar have revealed similar countericonic errors in acquisition. A study by Richard Meier describes a child signing GIVE erroneously, in a sentence meaning 'give the plate to him'. In the adult system, the verb agrees for the subject and the indirect object (i.e., the recipient), which is iconic with the real world activity of giving someone something. In the example, the child erroneously marks agreement with the direct object. He moves his hand toward the thing to be given, rather than the recipient -- a gesture that seems iconically interpretable as 'give something to the plate' (cited in Bellugi and Klima 1982). Here too, the child not only neglects to avail himself of iconic cues, he seems oblivious to them, focusing instead on the formal ingredients of the system -- in this case, the reference points in the discourse. As in the acquisition of spoken language, the child acquiring sign language sometimes gets these formal elements mixed up.

So, although it would seem that the iconicity in the visual modality would have a helpful effect on the process of language acquisition, we find that children do not seem to be attuned to certain obviously iconic aspects of signs. They are treating signs as abstract words, and thus they are not facilitated by iconicity in cases where one might expect them to be. They are simply progressing according to the universal timetable for language acquisition.

Overall, studies of the acquisition of ASL in a number of deaf children have come to the conclusion that the natural acquisition of ASL is quite parallel to the natural acquisition of spoken language. In the end, it seems that the basics of ASL are acquired by deaf children by around the age of five years, just as in the acquisition of spoken language. This finding is quite important. For many years people thought that

sound and sound patterning was a vital part of language, and that there could be no natural human language that did not rely on sound. The arguments for the linguistic status of American Sign Language are strongly supported by the finding that it is acquired naturally, taking a course that parallels that of spoken language.

The idea of a biological timetable for language is also compatible with the idea that biology has its limits. Since Lenneberg (1967), it has been observed that there may be a 'critical period' during which exposure to language is required in order for the natural mechanisms used for its acquisition to be triggered. Learning language after this period seems to be qualitatively different from early language acquisition, in a way that is sometimes interpreted as loss of the brain's plasticity. Lenneberg used data about recovery after language loss due to traumatic or degenerative brain damage, and about second language learning, to argue that the critical period ends somewhere around puberty. Before that time, children can recover from aphasia or learn a second language much more easily than after this point.

His proposal was strengthened by the study of isolated children such as Genie, a girl who was discovered at the age of thirteen and a half after having been locked in a small room and not spoken to during her whole childhood. Genie was unable to learn many aspects of complex language even after her physical and mental condition were treated (Curtiss 1977). However, there are many questions about Genie's situation and those of other isolated children, and fortunately these cases are rare -- so few conclusions can be drawn about the critical age hypothesis from the study of delayed first language acquisition in normally-hearing children.

A unique opportunity for investigating the critical age hypothesis is presented by deaf children with hearing parents, however, because even in caring home environments, the age at which deaf children are exposed to sign language varies. Many deaf youngsters are not exposed to sign language at an early age, because their deafness is not diagnosed, or because their parents prefer to educate them in an oral-only manner, or simply because no one in the child's environment uses sign language. In most cases, these children have no natural input to serve as a model for acquiring a spoken language, and their acquisition of sign language may begin as late as at the age of five, when they enter school, or perhaps even later.¹⁷ What, then, does sign language development in these children tell us about the critical period hypothesis? Here we may consider the gesture systems usually developed by young deaf children in the absence of a sign language model, often called 'Home Sign'; the consequences of the late acquisition of conventional sign languages, where a model is only presented for the child in later childhood; and the birth of a new sign language in a new deaf community.

In a series of extensive studies of these systems, Goldin-Meadow and colleagues¹⁸ have found that children systematically develop names for things, labels for actions, and ways to combine elements which are strikingly like those of real languages. The home sign systems are far from a fully developed language, but they

¹⁷ Nowadays, many deaf youngsters in some countries are exposed to some form of signing at a relatively early age through school, community, or home programs which may begin when the child is little over a year old. However, even now many children are not exposed to sign language, or even any contrived sign system, until much later.

¹⁸ See Goldin-Meadow and Mylander, 1990, for a review.

share characteristics with language which tell us about its 'resilience' (in Goldin-Meadow's terms). As far as we know, there is no 'Home Talk' -- the circumstances for its development do not exist. Only the study of sign systems allows us to observe the in-born drive for language which creates some kind of formal system even in the complete absence of experience.

Often, such children eventually are exposed to sign language and grow up to be adults who use it as their primary form of communication. How perfectly is the grammar of a sign language acquired when exposure to it begins after the critical period? In studies of adults who have used ASL for many years (e.g., Newport, 1990) it has been found that the age at which exposure to language began is critical for the eventual acquisition of a complete grammar. They find that even after 50 years of signing, people who were exposed to ASL only after the age of 13 systematically differ in their use of some of the complex mechanisms of ASL, as compared with similar-aged adults who acquired ASL from birth in signing homes. These later learners are fully expressive and use many of the same structures which the native learners use. However, their use of verbs of motion and location constructions as well as verb agreement, for example, is often very different. These results also support Lenneberg's proposal that there is a critical period for language acquisition, in a way which would not have been discovered if not for the study of sign languages.

The study of the development of a nascent sign language offers a unique perspective on the human language capacity and the critical age hypothesis. Research conducted by Judy Kegl, Ann Senghas and their colleagues (Senghas 1995), has been charting the development of a new sign language in Nicaragua, where deaf people had been isolated from one another until 1979. At that time a school was established for deaf children, and a communication system of signs immediately began to develop spontaneously. The system that developed among the first group of signers is not fully contentionalized, and it is relatively simple in structure, much like spoken pidgins. The older children in Nicaragua had had no language model when they were at the critical age, so their communication remains pidgin-like. Over time, however, as children as young as four years old began to come to the school and take the pidgin system of the older children as a model, a more systematic and contentionalized language began to emerge in these younger signers. This language includes certain grammatical characteristics that have been found by linguists in established sign languages. This study shows that the human brain will create a communication system as soon as people congregate and have a need to communicate. Like creole studies in spoken language, it also shows that children have the capacity to further expand and regularize even relatively simple input and make it into a bona fide language.

4. Neural Control of Sign Languages

Neurolinguists attempt to gain insight into the nature of language by determining which areas of the brain the control of various components of the language system. One way in which this is done is by studying the performance of people who have incurred brain damage, such as the localized damage resulting from strokes. In hearing, speaking people, numerous studies have found that damage to certain areas of the left cerebral hemisphere typically results in some type of language dysfunction.

Language deficits that result from brain damage are called *aphasia*. There are different types of aphasia, in which damage to different areas of the brain result in different types of language deficits. It is assumed that if a given function y is lost after damage to a certain area A , then that area is involved in the control or processing of that function. In this realm of investigation as well, similarities between signed and spoken languages have been found.

Although damage to areas of the left hemisphere results in aphasia in hearing subjects, damage to areas of the right hemisphere typically do not. On the other hand, damage to the right hemisphere frequently results in the loss of various types of spatial functioning. For example, patients with damage to the right hemisphere may be unable to draw a complete picture of a clock (typically neglecting the left side), or they may get lost in places that were very familiar to them before the brain damage.

It was shown in section 1 that the use of space plays an important role in the grammar of sign languages. For example, verb agreement and verbs of motion and location forms described there both involve spatial representation and manipulation. This situation, in which spatial cognition operations are directly related to linguistic cognition, prompts basic questions about brain organization with respect to spatial and linguistic functions in deaf signers. Several studies of deaf signers who have suffered brain damage have revealed patterns of language breakdown which emphasize the similarity rather than the difference between signed and spoken language in the mapping of both linguistic and spatial abilities within the brain.¹⁹

Poizner, Klima and Bellugi (1987) present case studies of six deaf patients with brain damage, and they show a striking difference between deaf patients with damage to the right versus left hemispheres. Like hearing patients, deaf signers who have left hemisphere brain damage have aphasia - in this case, aphasia for sign language. Some patients have very slow, awkward signing, like the speech of a 'Broca's aphasic' (named after the French physician who first associated the linguistic breakdown with damage to a particular area of the brain). Others have signing which is more fluent, but which doesn't make sense, like a 'Wernicke's aphasic' (a syndrome which results from damage to a different area of the left hemisphere). However, these patients have generally intact spatial cognitive abilities, such as drawing, face recognition, or localization of objects.

In contrast, deaf signers who experience damage to the right hemisphere have severe spatial deficits. They show left neglect, get lost in the hospital, and lose the ability to draw or show spatial relations, just like hearing patients with right hemisphere damage. However, the most important point is this: their signing is not impaired. They sign fluently and meaningfully, even using the 'spatial' grammatical devices, although they show some comprehension deficits, a point we will return to in Section 5.2. This provides strong evidence that sign languages are controlled in the left hemisphere, where spoken language is controlled, rather than in the right hemisphere, where visuo-spatial abilities are controlled. These results imply that neural specialization for language is determined more by the type of cognitive operation involved -- linguistic or spatial -- than by the physical channel that mediates these operations.

¹⁹ See Corina (1998) and Mehler and Peperkamp (to appear) for overviews of the neural control of sign language.

The evidence for a human language capacity that transcends the physical channel for its expression is by now diverse and compelling. There is something about human cognition that converges on a complex and rich language system with particular formal and even neurological characteristics, even when the evolutionarily preferred channel for its transmission is not available.²⁰

Yet this is still not the whole story. Some recent findings and new interpretations of existing results offer tough challenges to certain received views, and point the way toward important research in the future.

5. Recent challenges

A context for the future investigation of the relationship between language and cognition is an existing fundamental dispute about the nature of the language faculty. At one extreme is the strong Chomskyan view that language is an “organ”, innately specified, and both computationally and neurologically divorced from other aspects of cognition (e.g., Chomsky 1986). Other scholars argue that the experience of the child acquiring language plays a stronger role in determining language form. Jackendoff (1997) develops a theory according to which language is the outcome of a combination of factors, some specific to language (and possibly genetically specified), and others that tap more general concepts and knowledge about the world.

We now turn to certain outstanding questions about sign language that bear on this controversy. When they are seriously addressed, we believe the answers will lead us to a far deeper understanding of the language capacity than would have been possible without sign language research.

5.1. Basic, unexplained similarities among sign languages.

We have argued that sign languages bear important similarities to spoken languages. But we have only hinted at how similar the grammatical structures of sign languages are to one another. As Elissa Newport stressed in a recent address to sign language researchers²¹, this important generalization needs to be explained.

Using various grammatical criteria, linguists sometimes find it instructive to group languages into categories or types. These criteria may be applied at any level of analysis -- syntax, morphology, or phonology. For example, some languages have the Swahili type of morphology (see examples 12-13); others have the Navaho type (see example 14); etc. In syntax, some languages have Subject-Verb-Object word order; others have Verb-Subject-Object, for example. Phonologically, some languages allow several consonants to occur together before a vowel appears; others allow only one consonant at the beginning of a syllable. The point is that spoken languages may fall into one of any of a number of categories at each level of description.

²⁰ Presumably, if evolution had selected both modalities, there would be hearing communities that just happen to use a sign language for their primary means of communication. Since no such communities are known, we may assume that the evolutionary preference is for spoken language, whatever the reason. We thank Peter MacNeilage (p.c.) for bringing this reasoning to our attention.

²¹ Newport, Elissa L. (1996) *Sign Language Research in the Next Millenium*. keynote address, conference on Theoretical Issues in Sign Language Research. Montreal.

As we have hinted in section 1, in many ways, sign languages form a single language type, and one to which no spoken language belongs. If this is the case, then some essential questions arise, for both cognitive psychology and for linguistics. In the following paragraphs, we will demonstrate some of the typological traits of sign languages.²²

Let us begin with the relationship between the elements of form and meaning. In figure 6 ('a coin is lying there'), we showed a complex sign, with three meaningful elements or morphemes. We pointed out that some spoken languages have equally complex forms, with substantively the same types of morphemes in them. But there are two important generalizations that we now wish to emphasize: (1) all sign languages that we know of have precisely this type of morphology (American Sign Language, Israeli Sign Language, British Sign Language, Danish Sign Language, Swedish Sign Language, Japanese Sign Language); and (2) despite the large number of meaning elements (morphemes) in signs of this type, they are all articulated essentially simultaneously, or within what may be viewed as a single syllable.

A moment's thought is enough to convince the reader that (1) is not true of spoken languages. Languages like English, for example, have nothing even remotely like this sort of word structure. As for (2), the spoken language equivalent would be a language like Navaho in example (14) above, but in which all the different meaning elements were pronounced within a single syllable. Such a spoken language analogue - - a language whose words contain many meaningful components within a single syllable -- does not exist.

The sign language system is rule governed, grammatical, and violates no principles of universal grammar that we are aware of. It is also acquired by children at an age appropriate for a complex morphological system.²³ Yet the details of its form and use are particular to sign languages -- all sign languages.

All sign languages also have the type of verb agreement we described in section 1. The literature on the subject includes American Sign Language, British Sign Language, Taiwan Sign Language, Swedish Sign Language, Japanese Sign Language, Italian Sign Language, Danish Sign Language, Sign Language of the Netherlands, Israeli Sign Language, and Australian Sign Language. In addition to formal similarity, all sign languages apparently also share the division into four classes of verbs which are arguably determined on the basis of meaning

These similarities are so robust that they emerge spontaneously in the contact language used among signers whose native sign languages are not mutually intelligible. Supalla and Webb (1995) studied deaf lecturers at international conferences, communicating to an audience of signers of over twenty different sign languages. In a

²² In the discussion, we speak of 'sign languages' or 'all sign languages'. What we mean by this is all sign languages about which we have relevant information, including some sign languages not known to have any historical relationship to each other. Since we have no counterexamples to the generalizations we are about to express, we take the strongest position by assuming they are true of all sign languages.

²³ Lest the reader get the mistaken impression that this system is analogic to real world activity and not really grammatical, we point to a fascinating study by Newport and Supalla (see Newport, 1981). They show that in the early stages of acquisition, children decompose the many elements of this system, and produce them sequentially rather than simultaneously, resulting in sign sequences that appear far **less** like the real world event than the grammatical, adult forms do.

contact language called International Sign²⁴, these lecturers use the same kind of verb agreement that we have been describing here, in addition to other grammatical structures. The authors say that this is because these devices exist in the native sign languages of the lecturers -- whatever they may be. We make the following added observation: These results demonstrate that the signers, aiming to be understood, are (subconsciously) confident that these devices are sign language universal.

This contrasts sharply with the situation in spoken languages: not all spoken languages have agreement, and those that do are of many different types. Where there are classes of verbs with different agreement markers within a spoken language, these classes are arbitrary, and they are not determined by meaning. Nevertheless, we emphasize that these systems are grammatical and rule governed; they violate no known universal principle of grammar; and they are acquired by children at the same age that agreement is acquired in spoken languages.

In addition to these morphological similarities, sign languages all seem to share a particular type of phonological structure. For example, the constraint that only one finger group may characterize a sign applies to all sign languages we know of. Also, the fact that meaningful elements tend to be piled on simultaneously within single syllables, rather than linearly in a sequence, is a generalization about the phonological structure as well as the morphological structure of sign languages.

In short, sign languages form a language type. What makes this type different from the types posited for spoken languages is that the modality alone determines the type. And, no spoken language that we know of is of that type, although, unlike sign languages, spoken languages fall into many different language types. Furthermore, spoken languages fall into many different language types. These observations present us with a theoretical dilemma because they are not predicted by any explicit linguistic theory that we know of. The theory of universal grammar claims that certain generalizations can be made about the structure found in all languages, a claim that has been extended to include sign languages. However, this theory does not predict that a particular subset of these generalizations will characterize all sign languages. Future research must attempt to develop a paradigm for approaching this issue. Additional related challenges are posed by recent neurological findings.

5.2. Neurological Differences

As reviewed in section 4, aphasia studies show clearly that both spoken and signed languages are controlled in the left hemisphere. Some recent research on normal brains using modern techniques such as Positron Emission Tomography and functional Magnetic Resonance Imaging are suggestive of some differences in brain organization related to sign language. In particular, right hemisphere involvement has been shown in sign language processing by deaf and hearing native signers (see Corina, 1998, and Mehler and Peperkamp, to appear, for overviews).

²⁴ International Sign is the form of communication used by deaf people with no common sign language, when they meet, for example at international conferences. It is not a contrived language, like Esperanto (or its sign language counterpart, Gestuno, neither of which has caught on), but rather arose naturally out of a contact situation.

One research group used Regional Cerebral Blood Flow and Positron Emission Tomography to examine sign and spoken language representation in hearing native signers (hearing people born to deaf parents who learned sign language as a first language). They found bilateral activation for both modalities in both studies. Another research group, using Event Related Potentials, similarly found bilateral activation for both modalities, for both deaf and hearing native signers. Using functional Magnetic Resonance Imaging, they also found bilateral activation for processing ASL by deaf and hearing native signers; however, they did not find bilateral representation for English.

In these studies, the classical left hemisphere regions have been implicated for processing sign language, but in addition, some areas of the right hemisphere have also shown activity. Recall that patients with right hemisphere lesions reorted in Section 4 also showed some comprehension deficits, indicating right hemisphere involvement in processing sign language. If it is true that the right hemisphere is involved in sign language processing, it will be important to consider why there might be such a difference between sign and oral languages (or between language users with and without early exposure to sign language). Certainly, the well-established fact that the right hemisphere is crucial for human visuo-spatial processing in general may play a role in explaining these findings. These possibilities overlap, but there are distinctions which are important for theoretical models of language (cf. Sandler 1993, Lillo-Martin 1997, and previous references in this section). Clearly, more research in this area is essential.

5.3. Putting the puzzle together

In an attempt to understand certain similarities across sign languages, some interesting suggestions have been made about the role of iconicity (transparent correspondence between form and meaning) in shaping sign language grammar. Such a possibility runs counter to the by now traditional view that grammatical structure and iconicity are mutually exclusive. This more traditional view assumed, with Saussure (1959), that the elements of language, to be language, must be arbitrary. Therefore, it was assumed to follow that whatever is iconic about sign language is not 'linguistic'. Nowadays, however, there is such an abundance of solid evidence that sign languages are real linguistic systems in every sense of the word, that it is possible to take a fresh look at the whole issue.

Allowing for the possibility that iconicity contributes to grammatical structure in sign language opens the door to the possibility that general cognitive concepts -- such as spatial relations among referents in a discourse and physical characteristics of objects and their motion -- interact directly with the grammatical system (Sandler 1993). Some schools of spoken language research suggest that iconicity plays a nontrivial role in spoken language structuring as well, though somewhat differently and to a more limited degree. In this context, it is reasonable, we believe, to develop research paradigms that examine the relationship between modality, iconicity, and grammatical structure. Only by studying the nature of language in the visual modality does this become possible. Attempts to create such paradigms will undoubtedly offer a much deeper understanding of language in general.

Another area meriting further exploration is the relation between Home Sign and developed sign languages. As sketched in Section 3, Goldin-Meadow and her

colleagues have discovered the kernels of a structured communication system in the home sign created by deaf children of hearing parents in the absence of a language model. In particular, it can be argued that the rudiments of both the verbs of motion and location system, and the verb agreement system, have been observed in these children. As we have explained, the communication system of these children is far simpler and less systematic than a developed language, and even what does exist differs from developed sign languages. Nevertheless, it seems significant that what these children develop without a model has characteristics that are not only language-like, but unmistakably sign language-like. In particular, the use of space in denoting the referents involved in verb-like signs (as in verb agreement), and the use of handshapes to iconically represent physical classes of objects (as in verbs of motion and location) are found.

As the study of the birth of a conventional sign language in Nicaragua reveals, the beginnings of the use of space for reference and handshape as a classifier in complex signs can become much more sophisticated and systematic in the space of one generation of signers. This rapid creolization of a Home Sign system to a sign language which has similar characteristics to other established sign languages reinforces our interest in accounting for the ubiquitous qualities of sign languages in an explanatory way.

A different line of inquiry that ought to be further pursued is the one begun by S. Supalla (e.g., 1990). He has observed deaf school children who have been exposed only to a contrived signing system in which signs are used to translate the words and morphemes of spoken language, and which involves none of the grammatical properties of sign language. In communication among themselves, these children add sign language-like elements, such as moving verbs in space to refer to subject or object referents, although they have not been exposed to a sign language model. When fit together with future studies in the other areas mentioned here, this work will provide additional important pieces to the puzzle.

5. Conclusion

The study of sign language provides a natural laboratory for isolating certain fundamental properties of human language apart from the modality in which it is transmitted. Doing so has confirmed the existence of purported language universals, such as a systematic sub-word level of structure, syntactic embedding and recursion, and particular types of complex word formation. It has also strengthened the claim that the acquisition of language by children is a natural and automatic process with a set timetable, pointing to some degree of genetic predisposition for the development of just such a system.

Certain modality specific characteristics have also been found: a tendency for simultaneous layering of linguistic structure and particular types of grammatical constructions that are at once linguistic in the formal sense, and in some way iconic. The discovery of these sign language properties brings to light observations about spoken language that seem to be determined by the modality alone, such as the tendency to string linguistic information out linearly, and the generally arbitrary nature of the lexicon and grammar. Before research on sign language, such characteristics were thought to be properties of language universally. In the light of sign language research, we may suggest that these properties are artifacts of the oral-aural modality.

Our work is cut out for us. An important goal of future research must be to develop models of language that explain the clustering of characteristics found in sign languages, as well as the fact that they conform to more general linguistic universals. In developing such models, we are charged with an equally important task: explaining precisely what it is about the spoken language modality that makes it different from sign language. Only by examining these two natural language systems together can we reach a complete understanding of the human genius for language.

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