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Edited by Richard P. Meier, Kearsy Cormier and David Quinto-Pozos
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1 Why different, why the same? Explaining effects and non-effects of modality upon linguistic structure in sign and speech

Richard P. Meier

1.1 Introduction

This is a book primarily about signed languages, but it is not a book targeted just at the community of linguists and psycholinguists who specialize in research on signed languages. It is instead a book in which data from signed languages are recruited in pursuit of the goal of answering a fundamental question about the nature of human language: what are the effects and non-effects of modality upon linguistic structure? By modality, I and the other authors represented in this book mean the mode – the means – by which language is produced and perceived. As anyone familiar with recent linguistic research – or even with popular culture – must know, there are at least two language modalities, the auditory–vocal modality of spoken languages and the visual–gestural modality of signed languages. Here I seek to provide a historical perspective on the issue of language and modality, as well to provide background for those who are not especially familiar with the sign literature. I also suggest some sources of modality effects and their potential consequences for the structure of language.

1.2 What's the same?

Systematic research on the signed languages of the Deaf has a short history. In 1933, even as eminent a linguist as Leonard Bloomfield (1933:39) could write with assurance that:

> Some communities have a gesture language which upon occasion they use instead of speech. Such gesture languages have been observed among the lower-class Neapolitans, among Trappist monks (who have made a vow of silence), among the Indians of our western plains (where tribes of different language met in commerce and war), and among groups of deaf-mutes.
>
> It seems certain that these gesture languages are merely developments of ordinary gestures and that any and all complicated or not immediately intelligible gestures are based on the conventions of ordinary speech.

Why Bloomfield was so certain that speech was the source of any and all complexity in these gesture languages is unclear. Perhaps he was merely echoing

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Edward Sapir (1921:21) or other linguists who had articulated much the same views.

Later, Hockett (1960) enumerated a set of design features by which we can distinguish human language from the communication systems of other animals and from our own nonlinguistic communication systems. The first of those 13 design features – the one that he felt was "perhaps the most obvious" (p.89) – is the vocal-auditory channel. Language, Hockett argued, is a phenomenon restricted to speech and hearing. Thus, the early conclusion of linguistic research was that there are profound differences between the oral–aural modality of spoken languages and the visual–gestural modality of Bloomfield's "gesture languages." On this view, those differences were such that human language was only possible in the oral–aural modality.

However, the last 40 years of research – research that was started by William Stokoe (1960; Stokoe, Casterline, and Croneberg 1965) and that was thrown into high gear by Ursula Bellugi and Edward Klima (most notably, Klima and Bellugi 1979) – has demonstrated that there are two modalities in which human language may be produced. We now know that signed and spoken languages share many properties. From this, we can safely identify many non-effects of the modality in which language happens to be produced; see Table 1.1. Signed and spoken languages share the property of having conventional vocabularies in which there are learned pairings of form and meaning. Just as each speech community has its own idiosyncratic pairings of sound form and meaning, so does each sign community. In sign as in speech, meaningful units of form

Table 1.1 *Non-effects of modality: Some shared properties between signed and spoken languages*

- Conventional vocabularies: learned pairings of form and meaning.
- Duality of patterning: meaningful units built of meaningless sublexical units, whether units of sound or of gesture:
  - Slips of the tongue/Slips of the hand demonstrate the importance of sublexical units in adult processing.
- Productivity: new vocabulary may be added to signed and spoken languages:
  - Derivational morphology;
  - Compounding;
  - Borrowing.
- Syntactic Structure:
  - Same parts of speech: nouns, verbs, and adjectives;
  - Embedding to form relative and complement clauses;
  - Trade-offs between word order and verb agreement in how grammatical relations are marked: rich agreement licenses null arguments and freedom in word order.
- Acquisition: similar timetables for acquisition.
- Lateralization: aphasia data point to crucial role for left hemisphere.

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are built of meaningless sublexical units, whether units of sound or units of manual gesture; thus signed and spoken languages amply demonstrate duality of patterning, another of Hockett's design features of human language. Slips of the tongue and slips of the hand show that in sign, as in speech, these sublexical units of form are important in the adult's planning of an utterance; the fact that speech phonemes or sign handshapes can be anticipated, perseverated, or switched independently of the word or sign to which they belong demonstrates the "psychological reality" of such units (Fromkin 1973; Klima and Bellugi 1979). The chapter in this volume by Annette Hohenberger, Daniela Happ, and Helen Leuninger provides the first crucial evidence that the kinds of slips of the hand found in American Sign Language (ASL) by Klima and Bellugi are also encountered in other sign languages, in this instance German Sign Language (*Deutsche Gebärdensprache* or DGS). The kinds of online psycholinguistic tasks that David Corina and Ursula Hildebrandt discuss in their chapter may offer another window onto the psycholinguistic reality of phonological structure in signed languages.

Like spoken languages, signed languages can expand their vocabularies through derivational processes (Supalla and Newport 1978; Klima and Bellugi 1979), through compounding (Newport and Bellugi 1978; Klima and Bellugi 1979), and through borrowing (Padden 1998; Brentari 2001). Borrowings enter the vocabulary of ASL through the fingerspelling system (Battison 1978) and, recently, from foreign signed languages, which are a source of place names in particular. In the fact that they add to their vocabularies through rule-governed means and in the fact that novel messages may be expressed through the constrained combination of signs and phrases to form sentences, signed languages are fully consistent with another of Hockett's design features: productivity.

In the syntax of signed languages, we find evidence that signs belong to the same "parts of speech" as in spoken languages. In ASL, consistent morphological properties distinguish nouns such as CHAIR from semantically and formationally related verbs, in this instance SIT (Supalla and Newport 1978). ASL and other signed languages exhibit recursion; for example, sentence-like structures (clauses) can be embedded within sign sentences (e.g. Padden 1983). Word order is one means by which ASL and other signed languages distinguish subject from object (Fischer 1975; Liddell 1980). An inflectional rule of verb agreement means that the arguments of many verbs are marked through changes in their movement path and/or hand orientation (Padden 1983, among others).[1] As in such Romance languages as Spanish and Italian, there is a tradeoff between word order and rich morphological marking of argument structure, the result

[1] For a recent critique of the analysis of this property of verbs as being a result of agreement, see Liddell (2000), but also see Meier (2002) for arguments from child language development suggesting that what has been called agreement in signed languages is properly viewed as a linguistic rule.

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being that when arguments are signaled morphologically ASL exhibits "null arguments," that is, phonologically empty subjects and objects (Lillo-Martin 1991). As Diane Lillo-Martin reviews in her chapter, Brazilian Sign Language – unlike ASL, perhaps – allows a further tradeoff, such that agreeing verbs sanction preverbal objects, whereas only SVO (subject – verb – object) order is permitted with non-agreeing verbs (Quadros 1999).

Studies of the acquisition of ASL and other signed languages have revealed strong evidence that signed languages are acquired on essentially the same schedule as spoken languages (Newport and Meier 1985; Meier 1991; Petitto and Marentette 1991). There is evidence of an optimal maturational period – a critical period – for the acquisition of signed languages, just as there is for the acquisition of spoken languages (Mayberry and Fischer 1989; Newport 1990). In the processing of signed languages, as in the processing of spoken languages, there is a crucial role for the left hemisphere (Poizner, Klima, and Bellugi 1987) although there is ongoing controversy about whether there might be greater right hemisphere involvement in the processing of signed languages than there is in spoken languages (e.g., Neville, Bavelier, Corina, Rauschecker, Karni, Lalwani, Braun, Clark, Jezzard, and Turner 1998; and for discussion of these results, Corina, Neville, and Bavelier 1998; Hickok, Bellugi, and Klima 1998).

On the basis of results such as those outlined above, there were two conclusions that many of us might have drawn in the early 1980s. One conclusion is unassailable, but the other is more problematic:

Conclusion 1: The human language capacity is plastic: there are at least two modalities – that is, transmission channels – available to it. This is true despite the fact that every known community of hearing individuals has a spoken language as its primary language. It is also true despite plausible claims that humans have evolved – at least in the form of the human vocal tract – specifically to enable production of speech.

The finding that sign and speech are both vehicles for language is one of the most crucial empirical discoveries of the last decades of research in any area of linguistics. It is crucial because it alters our very definition of what language is. No longer can we equate language with speech. We now know that fundamental design features of language – such as duality of patterning, discreteness, and productivity – are not properties of a particular language modality. Instead these design features are properties of human language in general: properties presumably of whatever linguistic or cognitive capacities underlie human language. Indeed, we would expect the same properties to be encountered in a third modality – e.g. a tactile gestural modality – should natural languages be indentified there.[2]

Conclusion 2: There are few or no structural differences between signed and spoken languages. Sure, the phonetic features are different in sign and speech: speech does

[2] In his contribution to this volume, David Quinto-Pozos discusses how deaf-blind signers use ASL in the tactile–gestural modality.

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not have handshapes and sign does not have a contrast between voiced and nonvoiced segments, but otherwise everything is pretty much the same in the two major language modalities. Except for those rules that refer specifically to articulatory features – or to auditory or visual features – any rule of a signed language is also a possible rule of a spoken language, and *vice versa*.

It is this second conclusion that warrants re-examination. The hypothesis that there are few or no structural differences between sign and speech is the subject of the remainder of this chapter. The fact that we know so much more now about signed languages than we did when William Stokoe began this enterprise in 1960 means that we can be secure in the understanding that discussion of modality differences does not threaten the fundamental conclusion that signed languages are indeed languages. The last 40 years of research have demonstrated conclusively that there are two major types of naturally-evolved human languages: signed and spoken.

Why should we be interested in whether specific aspects of linguistic structure might be attributable to the particular properties of the transmission channel? Exploration of modality differences holds out the hope that we may achieve a kind of explanation that is rare in linguistics. Specifically, we may be able to explore hypotheses that this or that property of signed or spoken language is attributable to the particular constraints that affect that modality.

1.3 Why is it timely to revisit the issue of modality effects on linguistic structure?

Several developments make this a good time to reassess the hypothesis that there are few fundamental differences between signed and spoken languages. First, our analyses of ASL – still the language that is the focus of most research on signed languages – are increasingly detailed (see, for example, Brentari 1998; Neidle *et al.* 2000). Second, there are persistent suggestions of modality differences in phonological and morphological structure, in the use of space, in the pronominal systems of signed languages, and in the related system of verb agreement.

It is a third development that is most crucial (Newport and Supalla 2000): there is an ever-increasing body of work on a variety of signed languages other than ASL. Even in this one volume, a range of signed languages is discussed: Annette Hohenberger, Daniela Happ, and Helen Leuninger discuss an extensive corpus of experimentally-collected slips of the hand in German Sign Language (DGS). Roland Pfau analyzes the syntax of negation in that same language, while Gladys Tang and Felix Y. B. Sze discuss the syntax of noun phrases in Hong Kong Sign Language (HKSL). Anne-Marie P. Guerra Currie, Keith Walters, and I compare basic vocabulary in four signed languages: Mexican, French, Spanish, and Japanese. Christian Rathmann and Gaurav Mathur touch on a variety of signed languages in their overview of verb agreement: not only

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ASL, but also DGS, Australian Sign Language, and Japanese Sign Language (*Nihon Syuwa* or NS). Gary Morgan and his colleagues discuss how Christopher – a hearing language savant – learned aspects of British Sign Language (BSL). Research on signed languages other than ASL means that discussion of modality differences is not confounded by the possibility that our knowledge of signed languages is largely limited to one language that might have many idiosyncratic properties. Just as we would not want to make strong conclusions about the nature of the human language capacity on the basis of analyses that are restricted to English, we would not want to characterize all signed languages just on the basis of ASL.

1.4 Why might signed and spoken languages differ?

Signed and spoken languages may differ because of the particular characteristics of the modalities in which they are produced and perceived; see Table 1.2. I mention three sets of ways in which the visual–gestural and oral–aural modalities differ; these differences between the language modalities are potential sources of linguistic differences between signed and spoken languages. At this point in time, however, we have few conclusive demonstrations of any such effects. In addition to those factors that pertain to specific properties of the two language modalities, I mention a fourth possible source of differences between signed and spoken languages: Signed and spoken languages may differ not only because of characteristics of their respective channels, but because of demographic and historical factors that suggest that sign languages are, in general, rather young languages. Young languages may themselves be distinctive. However, even here a property of the visual–gestural modality may come into play: one resource for the development of signed languages may be the nonlinguistic gestures that are also used in the visual–gestural modality.

1.4.1 The articulators

I turn first to the differing properties of the articulators in sign and speech (cf. Meier 1993). That the hands and arms are in many ways unlike the tongue,

Table 1.2 *Possible sources of modality effects on linguistic structure*

1. Differing properties of the articulators
2. Differing properties of the perceptual systems
3. Greater potential of the visual–gestural system for iconic and/or indexic representation
4. The youth of signed languages and their roots in nonlinguistic gesture

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Table 1.3 *Some properties of the articulators*

Sign	Speech
Light source external to signer	Sound source internal to speaker
Sign articulation not coupled (or loosely coupled) to respiration	Oral articulation tightly coupled to respiration
Sign articulators move in a transparent space	Oral articulators largely hidden
Sign articulators relatively massive	Oral articulators relatively small
Sign articulators paired	Oral articulators not paired
No predominant oscillator?	Mandible is predominant oscillator

mandible, lips, and velum surely comes as no surprise to anyone.[3] Table 1.3 lists a number of ways in which the oral and manual articulators differ. The oral articulators are small and largely hidden within the oral cavity; the fact that only some of their movements are visible to the addressee accounts for the failure of lipreading as a means of understanding speech. In contrast, the manual articulators are relatively large. Moreover, the sign articulators are paired; the production of many signs entails the co-ordinated action of the two arms and hands. Yet despite the impressive differences between the oral and manual articulators, their consequences for linguistic structure are far from obvious. For example, consider the fact that the sound source for speech is internal to the speaker, whereas the light source for the reflected light that carries information about the signer's message is external to that signer.[4]

[3] The articulators in speech or sign seem so different that, when we find common properties of sign and speech, we are tempted to think that they must be due to general, high-level properties of the human language capacity or perhaps to high-level properties of human cognition. But a cautionary note is in order: there are commonalities in motoric organization across the two modalities that mean that some similar properties of the form of sign and speech may be attributable to shared properties of the very disparate looking motor systems by which speech and sign are articulated (Meier 2000b). Here are two examples: (1) in infancy, repetitive, non-linguistic movements of the hands and arms emerge at the same time as vocal babbling (Thelen 1979). This motoric factor may contribute to the apparent coincidence in timing of vocal and manual babbling (Petitto and Marentette 1991; Meier and Willerman 1995). More generally, all children appear to show some bias toward repetitive movement patterns. This may account for certain facts of manual babbling, vocal babbling, early word formation, and early sign formation (Meier, McGarvin, Zakia, and Willerman 1997; Meier, Mauk, Mirus, and Conlin 1998). (2) The sign stream, like the speech stream, cannot be thought of as a series of beads on a string. Instead, in both modalities, phonological units are subject to coarticulation, perhaps as a consequence of principles such as economy of effort to which all human motor performance – linguistic or not – is subject. Instrumented analyses of handshape production reveal extensive coarticulation in the form of ASL handshapes, even in very simple sign strings (Cheek 2001; in press).

[4] There are communication systems – both biological and artificial – in which the light source is internal: the most familiar biological example is the lightening bug.

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This fact may limit the use of signed languages on moonless nights along country roads, but may have no consequence for how signed languages are structured.[5]

To date, the articulatory factor that has received the most attention in the sign literature involves the relative size of the articulators in sign and speech. In contrast to the oral articulators, the manual articulators are massive. Large muscle groups are required to overcome inertia and to move the hands through space, much larger muscles than those required to move the tongue tip. Not surprisingly, the rate at which ASL signs are produced appears to be slower than the rate at which English words are produced, although the rate at which propositions are produced appears to be the same (Bellugi and Fischer 1972; Klima and Bellugi 1979). How can this seeming paradox be resolved? Klima and Bellugi (1979; see also Bellugi and Fischer 1972) argued that the slow rate of sign production encourages the simultaneous layering of information within the morphology of ASL; conversely, the slow rate of sign production discourages the sequential affixation that is so prevalent in spoken languages.[6] Consistent with this suggestion, when Deaf signers who were highly experienced users of both ASL and Signing Exact English (SEE) were asked to sign a story, the rate at which propositions were produced in SEE was much slower than in ASL (a mean of 1.5 seconds per proposition in ASL, vs. 2.8 seconds per proposition in SEE). In SEE, there are separate signs for the morphology of English (including separate signs for English inflections, function words, and derivational morphemes). In this instance an articulatory constraint may push natural signed languages, such as ASL, in a particular typological direction, that is, toward nonconcatenative morphology. The slow rate at which propositions are expressed in sign systems such as SEE that mirror the typological

[5] Similarly, the use of spoken languages is limited in environments in which there are very high levels of ambient noise, and in such environments – for example, sawmills – sign systems may develop (Meissner and Philpott 1975).

[6] Measurements of word/sign length are, of course, not direct measurements of the speed of oral or manual articulators; nor are they measures of the duration of movement excursions. Some years ago, at the urging of Ursula Bellugi, I compared the rate of word production in English and Navaho. The hypothesis was that the rate of word production (words/minute) would be lower in Navaho than in English, consistent with the fact that Navaho is a polysynthetic language with an elaborate set of verbal prefixes. The results were consistent with this hypothesis. Wilbur and Nolen (1986) attempted a measure of syllable duration in ASL. They equated movement excursion with syllable, such that, in bidirectional signs and in reduplicated forms, syllable boundaries were associated with changes in movement direction. On this computation, syllable durations in sign were roughly comparable at 250 ms to measures of English syllable duration that Wilbur and Nolen pulled from the phonetics literature. Note, however, that there is little phonological contrast – and indeed little articulatory change – across many of the successive "syllables" within signs; in a reduplicated or bidirectional form, the only change from one syllable to the next would be in direction of path movement. See Rachel Channon's contribution to this volume (Chapter 3) for a discussion of repetition in signs.

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organization of English may account for the fact that such systems have not been widely adopted in the Deaf community.

The two language modalities may also differ in whether they make a single predominant oscillator available for the production of language, as I discussed in an earlier paper (Meier 2000b). Oscillatory movements underlie human action, whether walking, chewing, breathing, talking, or signing. Although there are several relatively independent oral articulators (e.g. the lips, the tongue tip, the tongue dorsum, the velum, and the mandible), MacNeilage and Davis (1993; also MacNeilage 1998) ascribe a unique status to one of those articulators. They argue that oscillation of the mandible provides a "frame" around which syllable production is organized. Repeated cycles of raising and lowering the mandible yield a regular alternation between a relatively closed and relatively open vocal tract. This articulatory cycle is perceived as an alternation between consonants and vowels. Mandibular oscillation may also be developmentally primary: MacNeilage and Davis argue that, except for the mandible, children have little independent control over the speech articulators; cycles of raising and lowering the mandible account for the simple consonant–vowel (CV) syllables of vocal babbling.

When we observe individual ASL signs we see actions – sometimes repeated, sometimes not – of many different articulators of the arm and hand. ASL signs can have movement that is largely or completely restricted to virtually any joint on the arm: The sign ANIMAL requires repeated in-and-out movements of the shoulder. Production of the sign DAY entails the rotation of the arm at the shoulder. The arm rotates toward the midline along its longitudinal axis. The signs GOOD and GIVE (citation form) are articulated through the extension of the arm at the elbow, whereas TREE involves the rotation of the forearm at the radioulnar joint. YES involves the repeated flexion and extension of the wrist. The movement of still other signs is localized at particular articulators within the hand (e.g. TURTLE: repeated internal bending of the thumb; BIRD: repeated bending of the first finger at the first knuckle; COLOR: repeated extension and flexion of the four fingers at the first knuckle; BUG: repeated bending at the second knuckle). Still other signs involve articulation at more than one joint; for example, one form of GRANDMOTHER overlays repeated rotation of the forearm on top of an outward movement excursion executed by extension of the arm at the elbow. Facts such as these suggest that it will be hard to identify a single, predominant oscillator in sign that is comparable to the mandibular oscillation of speech. This further suggests that analysts of syllable structure in sign may not be able to develop a simple articulatory model of syllable production comparable to the one that appears possible for speech. On the view suggested by MacNeilage and Davis's model, speech production – but not sign production – is constrained to fit within the frame imposed by a single articulator.

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Table 1.4 *Some properties of the sensory and perceptual systems subserving sign vs. speech*

Sign	Speech
Signer must be in view of addressee	Speaker need not be in view of addressee
High bandwidth of vision	Lower bandwidth of audition
High spatial resolution of vision; lower temporal resolution than audition	High temporal resolution of audition; lower spatial resolution than vision
Visual stimuli generally not categorically perceived	Categorical perception of speech (and of some highly dynamic nonspeech stimuli)
Articulatory gestures as the object of perception	Acoustic events as the object of perception

1.4.2 The sensory or perceptual systems

A second source of linguistic differences between signed and spoken languages could lie in the differing properties of the sensory and perceptual systems that subserve the understanding of sign and speech (again see Meier 1993 for further discussion, as well as Diane Brentari's contribution to this book). In Table 1.4, I list some pertinent differences between vision and audition.[7] Specific claims about the relationship between these sensory/perceptual factors and linguistic structure have hardly been developed. One instance where we might make a specific proposal pertains to the greater bandwidth of the visual channel: to get a feel for this, compare the transmission capacity needed for regular telephone vs. a videophone. Greater bandwidth is required to transmit an adequate videophone signal, as opposed to a signal that is adequate for a spoken conversation on a standard telephone. The suggestion is that at any instant in time more information is available to the eye than the ear, although in both modalities only a fraction of that information is linguistically relevant.

A more concrete statement of the issue comes from an important discussion of the constraints under which spoken languages have evolved. Pinker and Bloom (1990:713) observed that "[The vocal–auditory channel] is essentially a serial interface . . . lacking the full two-dimensionality needed to convey graph or tree structures and typographical devices such as fonts, subscripts, and brackets.

[7] In an earlier article that addressed some of the same issues as discussed here (Meier 1993), I listed categorical perception as a modality feature that may distinguish the perception of signed and spoken languages. The results of early studies, in particular Newport (1982), suggested that handshape and place distinctions in ASL were not categorically perceived, a result that indicated to Newport that categorical perception might be a property of audition. Very recent studies raise again the possibility that distinctions of handshape and of linguistic and nonlinguistic facial expression may be categorically perceived (Campbell, Woll, Benson, and Wallace 1999; McCullough, Emmorey, and Brentari 2000).

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