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Sign Language Research at the Millennium

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Ursula Bellugi and Ed Klima hold a remarkable position in the field of sign language research, and also therefore in the broader field of the cognitive sciences. Within the field of sign language research, they established one of the two research groups that founded the field, and during the formative years of the field they were responsible both for producing most of the findings on sign language structure and acquisition and for training almost everyone who subsequently entered the field. It is therefore hard to overestimate the debt our field owes to them. Even more significant, however, is the fact that they framed the central questions of the field in such a way that this relatively small subarea has had an enormous impact on and importance to the entire enterprise of cognitive science and cognitive neuroscience. Their questions have always been the big ones: Are sign languages structured and acquired in the same ways as spoken languages, or are there important differences? Is language therefore a faculty specially developed and evolved in the auditory mode, or is there independence of language from modality? What does this tell us about the nature of language and about the nature of the cognitive and neural mechanisms that produce it? Because they have always framed their questions

in this way, those of us who have worked with them and have entered the field through working in their lab have also thought about these same "big questions." The result of continually keeping their eye (eyes?) on this perspective has meant that only 25 or 30 years of research by two profoundly thoughtful investigators and their students and collaborators have entirely changed the way the field of cognitive science thinks about language. Jerry Kagan recently asked one of us, in casual conversation, what the 10 most important findings in the field were. Only one came to mind: the findings of the last two decades on signed languages. We have been extremely fortunate to participate in the field during this period of time and to work with Ursula and Ed during important parts of it.

For the last Theoretical Issues in Sign Language Research (TISLR) conference in Montreal, Lissa was invited to give an address looking back and forward to the next millennium, asking what sign language research has found thus far and what our field needs to discover in our future work. This invitation prompted us to discuss together, at great length, what we thought about these issues. What we discovered, in part, was how much our answers to these questions were framed by Ursula and Ed in our earliest years in the field. In tribute to them, this chapter is an attempt to answer these same large questions with our own perspective on what research in the field of sign language structure, processing, and acquisition has suggested thus far.

THE PRE-SIGN LANGUAGE ERA

When we were graduate students (in the 1970s) and each first introduced to the field of psycholinguistics, the prevailing view was clear: Language was thought to have an essential and unique relation to the auditory–vocal mode. Table 7.1 lists a number of important lines of evidence supporting this view, each of which, at that time, looked quite empirically strong, and which together formed a coherent picture of the language faculty.

TABLE 7.1
Our Concept of Language in the 1960s and Early 1970s

- Speech is special: Categorical perception only for speech
- Linguistic universals apply only to spoken languages
- Specialized neural mechanisms for spoken language
- Language is qualitatively different from all nonlinguistic behavior (even including signed language, written language, gesture)

One line of evidence supporting this view came from the work on categorical perception, suggesting that there was a special "speech mode" for processing auditory linguistic material (Liberman, 1970). Research in this line of work showed that continua of speech stimuli, synthesized with continuously varying acoustic dimensions such as voice onset time or second formant frequency, were not perceived as continuously distinct; rather, such stimuli were perceived in phonetic categories, within which listeners were unable to distinguish further acoustic variation. Categorical perception was believed to be a mode of perception restricted to speech; in the earliest studies, even auditory stimuli very similar to speech, but not perceived as linguistic (e.g., inverted speech or the 50-millisecond "chirps" spliced out of the onset of speech stimuli), were not perceived categorically.

A second line of work concerned the discovery of linguistic universals and the accompanying claim that these universals were restricted to spoken languages. Greenberg (1963) and Chomsky (1965), among others, began to note in the middle 1960s that a wide variety of unrelated spoken languages shared a surprising number of structural properties or fell into a small number of distinct structural types. Although some of Stokoe's (1960) work on ASL phonology had already appeared at that time, most of the research on ASL had not yet begun, and none had yet impacted the linguistic community's view of language. An extremely interesting statement of the view of language held at that time appeared in an article published in *Cognition* by Osherson and Wasow (1976). In that article, Osherson and Wasow argued for specialized innate constraints or mechanisms underlying human spoken language abilities, using as their strongest claim the evidence that even apparently close systems, sharing many or all of the same communicative functions with spoken language, do not share either categorical perception or linguistic universals. Their two examples were writing systems and sign languages.

Similarly, all the available literature on neural mechanisms underlying language suggested that speech was special here as well. Neurological damage to specific areas of the left hemisphere could result in the loss of language without any accompanying loss of other motor or cognitive skills. By the Geschwind model (1972), these regions subdivided into linguistic components such as comprehension (relatively posterior) and production (relatively anterior).

Thus in many ways—structural as well as neural—language was thought to contrast with nonlinguistic behavior (e.g., gesture), and even with closely related behavior such as written language and sign language. If correct, this view was extremely interesting and theoretically powerful.

One would think, after all, that the structural properties and computational mechanisms involved in a behavioral domain would derive fairly directly from the computational functions this behavioral domain entailed. Converging lines of evidence to the contrary thus demanded a quite different way of thinking about the nature of language. The alternative that seemed obvious at the time was that a special set of mechanisms must have evolved for handling human language that were, for reasons of evolutionary history, inextricably linked to the auditory–vocal channels in which most human language use occurs.

We must emphasize, particularly to an audience of sign language researchers, that this is not at its core a view derived from a prejudiced or politically inappropriate view of sign languages. It could have been true—indeed, to some degree, could still be true—that a faculty for handling spoken language would be separate and distinct from one called into play for handling signed language, without denying that signed languages are legitimate, complex, and full human languages. It could have been that the universal principles of spoken languages are different from those of signed languages. But at the beginning of this era of research, it wasn't even clear that humans could develop a complex communicative system without the mouth and the ear.

THE FIRST PHASE OF SIGN LANGUAGE RESEARCH: DISCOVERIES ABOUT ASL

As already noted, Stokoe's earliest work on American Sign Language (ASL) preceded much of the research cited above. But research on ASL began in earnest during the 1970s, and began to impact the linguistic community in a major way at a Linguistic Society of America (LSA) meeting in 1973–1974. We ourselves were not yet at The Salk Institute (we both arrived there in 1974, Ted as Ursula's first graduate student and Lissa as a new Assistant Professor at UCSD); but the generation of students and collaborators who preceded us in working with Ursie and Ed—Harlan Lane, Susan Fischer, Nancy Frishberg, Robbin Battison, Pat Siple, and many others—were performing truly groundbreaking, landmark work on the structure and acquisition of ASL. We have been told by members of the audience at the 1973–1974 LSA meeting that the presentations of the lab at this meeting, reporting on the phonological structure of ASL and its path of historical change into a contrastive phonological system, received a standing ovation.

The research of the next 15 years not only brought us an understanding of ASL; it also changed the way the field viewed human language. In virtually every regard, and in many extremely surprising ways, ASL has turned out to be organized and acquired like other languages. This in turn has meant that language cannot be uniquely linked to the ear and mouth but must instead arise from mechanisms independent of those modalities.

Table 7.2 lists a number of findings and interpretations that resulted from this new field of research on ASL. The central findings came from an understanding of the linguistic structure of ASL, much of the work performed or begun by Ursula, Ed, and their collaborators and students (Klima, Bellugi et al., 1979). These linguistic analyses of ASL revealed that it is a language with a quite different type of structure than that of English, but one that is found among spoken languages (e.g., it shares certain typological similarities with Navajo). Word structure in ASL is quite complex, particularly in verbs. Typical verbs are marked morphologically for agreement in person and number with both subject and object, and for temporal aspect and other grammatical features common to verbs in other languages (Fischer, 1973; Padden, 1988). Verbs of motion are particularly complex, with stems involving morphemes for path, manner of motion, orientation, and classifier morphemes marking the semantic category or size and shape of both the moving object and a secondary object with respect to which the movement path occurs (T. Supalla, 1982). As is common in spoken languages with complex morphology, word order in ASL is relatively free, with an unmarked SVO order but a number of order-changing syntactic structures commonly used (e.g., topicalization of the object, subject, or VP). Moved constituents are obligatorily marked by grammaticized facial expressions, which are produced throughout the signing of the words of that constituent (Liddell, 1980). When verbs are marked for agreement and/or when discussing subjects and objects that have already been mentioned, the subject and object NPs may be omitted from the sen-

TABLE 7.2
Our Concept of Language Deriving From Research on ASL

- Language is special, no difference between spoken and signed language
- Linguistic universals apply to all languages
- Acquisition and processing universals apply to all languages (if input early)
- Same neural mechanisms apply to all languages (if input early)
- Language is qualitatively different from nonlinguistic behavior (now including only written language, gesture)

tence—that is, the language permits null arguments (Lillo-Martin, 1991). In short, the grammatical properties of ASL are unlike those of English but are quite familiar to students of other languages of the world. This body of findings thus suggests that principles of word and sentence structure are, at least to some degree, common to both signed and spoken languages and are not inherently connected to the auditory–vocal mode.

Studies of the online processing of ASL by fluent adult signers, of the representation of ASL in the brain, and of the acquisition of ASL by native-speaking Deaf children also show many similarities with the principles of processing, neurological organization, and acquisition of spoken languages of the world. For example, ASL is acquired on approximately the same timetable as spoken languages with similar typology. Acquisition begins with manual babbling appearing at around 10 months or earlier (Petitto & Marentette, 1991); first signs appear at about 1 year of age; two-sign sentences appear during the second year; and each of these stages show structural characteristics like those of other languages (Meier & Newport, 1990; Newport & Meier, 1985). Adult signers process ASL using the same types of parsing strategies as those used in the processing of spoken languages (Emmorey, 1991), and, like speakers of auditory–vocal languages, represent ASL in the left hemisphere of the brain (Neville, 1995; Poizner, Klima, & Bellugi, 1987).

One highly unusual feature of signing communities is that native users are so rare; 95% or more of Deaf signers are first exposed to their language beyond infancy and sometimes not until late childhood or even adulthood. This has therefore presented to researchers the opportunity to study of the effects of age of exposure on the mastery of a primary language. A number of such studies have shown that there is a substantial effect of age on the acquisition of ASL: native and early ASL learners show much more fluency, consistency, and complexity in the grammatical structures of the language, and more extensive and rapid processing abilities, than those who have acquired ASL later in life (Emmorey, 1991; Mayberry & Fischer, 1989; Newport, 1990). These effects persist even after as much as 50 years of daily use of ASL as a primary language (Newport, 1990). Together with the work of Lenneberg (1967) and Curtiss (1977) and also comparable effects of age of exposure on the acquisition of English as a second language in hearing foreigners (Johnson & Newport, 1989), these results provide important evidence of a critical, or sensitive, period for the acquisition of language.

All of these findings on ASL suggest that the cognitive abilities supporting language and its acquisition in humans are not restricted or spe-

cialized to speech but rather permit the development of signed as well as spoken languages. However, it is important to note that this striking similarity between signed and spoken languages arises predominantly from studying *one* sign language. As sign language researchers have begun to study other sign languages, some new and old questions reappear.

RECENT FINDINGS IN SIGN LANGUAGE RESEARCH: QUESTIONS ABOUT SIGN LANGUAGE TYPOLOGY, VARIATION, AND EMERGENCE

As we have begun to move beyond the study of a single sign language and examine other sign languages of the world, an unexpected first impression appears. For those of us accustomed to the sometimes wild differences among unrelated spoken languages, distinct signed languages look much less wildly different. Unrelated sign languages are certainly mutually unintelligible, as has been noted by many investigators, and vary greatly in their lexicons and basic word orders. But a long dinner among Deaf users of different sign languages will, after a while, permit surprisingly complex interchanges in a rapidly developed pidgin, and World Federation of the Deaf meetings are regularly and successfully conducted in such a pidgin (T. Supalla & Webb, 1995). Moreover, cross-linguistic research on sign languages does not yet include any languages that are radically different in typology from ASL. In short, whereas each sign language looks like some spoken language of the world, different sign languages thus far look unexpectedly like each other. Is this a mistaken impression from too early and too small a sample of cross-linguistic research? Is it the result of studying only young languages, which have also been claimed to look surprisingly like one another in the auditory–vocal mode? Or is it something important and revealing about the true nature of modality and language? Only further research can untangle these questions.

Table 7.3 lists a number of recent lines of research suggesting that there may be some important differences between signed and spoken languages that we have not yet fully understood. One of these lines of work concerns the acquisition of SEE2 (Signing Exact English), a sign system that has not developed naturally but was devised by adults for educational purposes. Sam Supalla (1986, 1989, 1991) showed that the closed-class morphology of SEE2 is not readily acquired by deaf children, even when this is the only communicative system to which they are exposed, and even

TABLE 7.3
More Recent Findings on Sign Languages: Unanswered Questions

- SEE2
- Cross-linguistic comparison of signed languages
- International Sign as a pidgin
- Home sign
- Nonlinguistic gesture
- Neural mechanisms

when they are exposed to it from relatively early in life. He suggested that this learning problem arises because SEE2 was devised with a type of morphology that is entirely commonplace in English and other spoken languages—consisting of multiple, phonologically different syllables in sequence—but that is quite unnatural for the visual–gestural mode. This may not in fact be the only structural problem in SEE2: There are a number of other linguistic oddities of SEE2 (e.g., not distinguishing phonologically between open-class [typically strong] and closed-class [typically weak] elements), which may be unnatural for both spoken and signed languages. It is therefore possible that many formal problems, not special to sign languages and their modality, make SEE2 difficult to learn. But S. Supalla's work raises the important possibility that there are natural differences between spoken and signed languages in the types of morphological and phonological structure that most readily develop.

A second set of findings that accords with S. Supalla's suggestion are the early results of cross-linguistic comparisons among sign languages that have arisen naturally in different parts of the world. Our own analysis of case marking and verb agreement in 15 different sign languages (T. Supalla & Webb, 1995; T. Supalla, 1997) shows a number of differences between these languages in the types of morphological devices they use. At the same time, however, there are also striking similarities among the languages, with all using locations and movement through space in common ways to mark grammatical agreement with subject and object. Investigators have also noted classifier structures in verbs of motion in many sign languages. Presumably because of such similarities among unrelated sign languages, speakers of mutually unintelligible sign languages are able to develop a signed pidgin (called International Sign) that retains these morphological structures and that is thus unexpectedly more complex than spoken pidgins (T. Supalla & Webb, 1995; Webb & T. Supalla, 1994).

In short, from what little we know thus far about sign languages of the world, it is possible that sign languages show more typological similarity to one another, at least in their morphological structure, than do an equivalent range of spoken languages.[1] Why might this be true? T. Supalla & Webb (1995) have suggested several possibilities. One important possibility is that we have not yet studied enough sign languages, and that the typological differences we find between spoken Navajo and Chinese also await us in signed languages that no one has yet analyzed. A second possibility is that the sign languages studied thus far are all quite young, with communities of Deaf signers only recently formed by forces such as public education. Young languages, spoken as well as signed, have been argued to share more structural properties with one another than is common among unrelated languages (Bickerton, 1981; Fischer, 1978). Sign languages may thus diverge from one another more as they develop longer histories. A third possibility, however, is that the visual–gestural modality may produce more uniformity of structure and typology than does the auditory–vocal modality.

In the auditory–vocal mode, there is a large distance between the nonlinguistic resources from which languages develop and the linguistic systems that eventually result. This is certainly not absolute: A number of interesting and important suggestions have been made about perceptual and motor constraints on spoken language structure. For example, we now know that the phonetic categories of languages arise from auditory perceptual categories that predate the phonetic contrasts both developmentally and evolutionarily. Nonetheless, compared with gesture, the auditory-vocal modes seem strikingly arbitrary, even empty. No isolated child has yet been discovered who has babbled an invented auditory language to her mother; no hearing participants, brought into the lab and asked to make sounds to one another, will quickly produce even the beginnings of Russian or Tagalog. This gap is filled, for well-developed languages, with a very wide array of relatively arbitrary systems of grammaticization, with some languages relying predominantly on linear order and others more heavily utilizing tone or contrasting segments for expressing the same functions. Infants are remarkable in the auditory–vocal mode for their

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[1]There is, however, no reason from available evidence to believe that there is special similarity among sign languages in their syntactic structure: Basic word order, for example, varies in the same way as in spoken languages.

ability to rapidly learn the widely differing patterns to which they are exposed (Saffran, Aslin, & Newport, 1996).

In contrast, in the visual–gestural mode, there appears to be a great deal more structure in nonlinguistic behavior, and also, perhaps, more uniform tendencies across sign languages to grammaticize these nonlinguistic resources in very similar ways. Deaf children raised in hearing families, without exposure to a sign language, will nonetheless develop a surprisingly rich "home sign" system (Goldin-Meadow & Mylander, 1990, 1998; Coppola, Senghas, Newport, & Supalla, 1997). Hearing adults, brought into the lab for a brief experiment and asked to gesture, do not produce well-structured or complex grammatical systems, but they do produce remarkable beginning use of the devices that appear in well-developed sign languages (Dufour, 1992; Singleton, Morford, & Goldin-Meadow, 1993). Even nonlinguistic gesture, produced by hearing people while speaking, has recently been shown to have more structure than previously believed. Webb (1996) studied hearing speakers ranging from a talk show host to a philosophy professor. She found that each has a recurring "lexicon" of gestures, many shared across speakers and some composed of smaller gesture parts (e.g., a recurring circle to convey repeated action, or a gesture to the head to accompany talk of mental states) that resemble some of the much more well-developed components of sign languages.

These seeds of structure in the visual–gestural mode—our human tendencies to use motion and space in particular ways to express conceptual and grammatical contrasts—may thus tend to propel sign languages more commonly toward one or a few of the several ways in which linguistic systems may be formed. On this view, each individual sign language is fully comparable, in complexity and typology, to spoken languages, each falling well within the expected range of linguistic structure; but the range of variation across distinct sign languages may be different, and more focused on particular types of organizational structure, than that for spoken languages. If this is correct—and, we reiterate, it may well be quite incorrect and based prematurely on too little cross-linguistic research—the relation between spoken and signed languages may be somewhat different than our field had initially anticipated. Universals of signed and spoken languages may neither be precisely the same as one another nor entirely different; rather, modality (along with other cognitive constraints that shape languages) may affect which of the available ways to build a linguistic system is utilized, and therefore where there is and is not cross-linguistic variation.

A clearer answer to these questions awaits a myriad of new lines of research: more cross-linguistic studies of distinct sign languages, particu-

larly those that have long histories but little contact with the Western sign languages already somewhat well studied; more analysis of how new languages emerge; more research on historical change in signed as well as spoken languages. We are enormously grateful to Ursula Bellugi and Ed Klima, who have not only forged the beginnings of this road and have provided the field with an understanding of the importance of sign language research to the cognitive sciences, but who have also pointed the way for all the rest of us.

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The Signs of Language Revisited

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An Anthology to Honor Ursula Bellugi and Edward Klima

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