

## **Chomsky and Signed Languages**

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### 1. Introduction and history

Chomsky's 'revolution' and the revolution in sign language linguistics (Lillo-Martin 2018) began around the same time, but they did not directly affect each other for a while. Before the publication of William Stokoe's 'Sign Language Structure' (Stokoe 1960), the natural sign languages of deaf communities were generally thought to be conglomerations of unstructured gestures and/or manual representations of spoken languages (although acknowledgment of the existence of natural signs goes back at least to Plato, and various scholars and users of sign languages recognized that they are rule-governed well before Stokoe's time). Stokoe's work, published in the University of Buffalo's Occasional Papers, reflected his training by Trager and Smith in structural linguistics and put forward an analysis of American Sign Language (ASL) undertaken in that vein. His proposals, that signs have parts and that signs are organized in grammatical ways, were not immediately embraced: a review of Stokoe's monograph published in *Language* was extremely negative (Landar 1961). Nevertheless, his work seems to have been more rapidly adopted in the linguistics community than by most of his own colleagues at Gallaudet College (now University); according to Eastman (1980), Stokoe's claims were ridiculed by many at his institution, but he had funding from NSF, with deaf colleagues produced a widely-recognized dictionary with grammatical information (Stokoe, Casterline, and Croneberg 1965), and by 1966 he was invited to give a presentation to the Georgetown University Round Table.

Stokoe himself was not enthusiastic about the application of generative grammar to sign languages in the early years (Tweney and Hoemann 1976), and never warmed up to it (Stokoe 1990). He emphasized the need to study the people who used a language and not focus on competence as an independent mental phenomenon. Still, the revolution he started was not immune from the influence of generative grammar, despite his own reluctance.

Linguistic research on sign languages in the 1960's and 1970's spread from Stokoe's Linguistics Research Laboratory at Gallaudet, with numerous researchers in the Washington, D.C. area, others at Berkeley, and the establishment in 1970 of the Laboratory for Language and Cognitive Neuroscience at the Salk Institute in La Jolla, CA, led by Ursula Bellugi and Edward S. Klima. Bellugi had completed her doctoral work with Roger Brown at Harvard, and her

husband Klima was a generative syntactician at MIT before moving to the University of California at San Diego. Bellugi and Klima's work on sign languages was therefore strongly influenced by Chomsky and his theories of generative grammar in a general way. They were very interested in understanding the linguistic rules underlying ASL, which they approached through analysis of data from native signers (using elicitation and judgment studies), psycholinguistics, acquisition, and studies of breakdown in signers with aphasia. While their work is very compatible with generative ideas, their focus in ASL analysis was not on specific generative mechanisms. However, as the following sections will demonstrate, numerous sign language scholars who were themselves mentored by Bellugi and Klima made specific contributions to generative analyses of sign languages, and/or connections to Chomsky's proposals about innateness.

The next two sections of this chapter will focus on Chomsky-inspired research on sign language grammar, and ways that the study of sign languages connects to theories of innateness, the two main ways that Chomsky's impact has been felt in sign linguistics. The final section will discuss implications of these findings.

## **2. Syntax and modularity**

What do Chomsky's theories of syntax say about sign languages? Chomsky himself says very little about sign languages. In his early works, sign languages aren't mentioned. Later, they occasionally come up, in a kind of acknowledgment of existence, but he makes no claims about how sign language grammars might work other than his claims about grammar in general. Specifically, in later works when he discusses the articulatory-perceptual or sensory-motor interface – and especially in the context of discussions of language evolution – he includes the option that this component involves sign languages. For example, in support of the argument that language is not coextensive with speech, Bolhuis, Tattersal, Chomsky and Berwick (2014) state, “However, speech and speech perception, while functioning as possible external interfaces for the language system, are not identical to it. An alternative externalization of language is in the visual domain, as sign language; even haptic externalization by touch seems possible in deaf and blind individuals” (Bolhuis et al. 2014, 1; see also Chomsky 2011). Hauser, Chomsky, and Fitch (2002) even include an image of a person using a sign language.

Numerous scholars have adopted the assumption that specific proposals made within the generative tradition ought to, then, apply to sign languages as well as spoken languages, from as early as the 1970's up to the current time. For example, Susan D. Fischer wrote what is considered the first generative syntactic analysis of a sign language (Fischer 1974). Her paper provided an *Aspects*-style transformational account of word order in ASL, including an argument that the Complex NP-constraint of Ross (1967) holds of rules for sentence topicalization and NP-backing (backgrounding). This paper led a group of sign linguists to decide that they no longer needed to make the argument that sign languages are real language, the point having been demonstrated so conclusively, as noted by Ronnie Wilbur in the Editor's Preface to the reprinting of Fischer's paper (Fischer 2009). Over decades, Fischer contributed numerous additional generative analyses, including work on word order change, verbal morphology, and a parametric X'-theoretic approach to what she called 'mini-topicalization', among many others (Fischer 1975; 1990; Fischer and Gough 1978).

Another early and influential work employing generative theory for the analysis of sign language data was that of Scott K. Liddell (Liddell 1980). Liddell's book thoroughly examined previous claims that ASL lacked subordination and other syntactic features. He pointed out that non-manual features – specific configurations of facial features, head position, and body movements – are often associated with specific syntactic structures, possibly accounting for why they had previously been overlooked. He proposed that non-manual markers exist in the phrase structure of a sentence and spread over command domains (Langacker's version, pre- c-command). Variants of his proposal have been taken up by later scholars, particularly Neidle et al. (1998; 2000), who argued that the spread of non-manuals over c-command domains reveals syntactic structure.

More researchers made generative proposals regarding sign languages in the 1980's (and beyond). Judy Shepard-Kegl (for whom Chomsky was a dissertation co-supervisor) proposed a detailed sub-lexical structure for ASL signs, and associated with that, she gave generative analyses of a number of phenomena, including clitics, pronouns, agreement, and null arguments (Shepard-Kegl 1985; Kegl 1987; 2003). Carol Padden (Padden 1983), worked within the framework of Relational Grammar, which was an alternative to Chomsky's proposals but maintained numerous foundational aspects of generative grammar and was clearly influenced by him. Padden identified three groups of verbs in ASL according to the types of inflectional

morphology they accept; this tri-partite division is adopted by most sign linguists to this day. Padden also proposed specific structural configurations used in ASL and provided syntactic arguments to identify subjects, embedded clauses, and other structures. I myself used the generative approach of the Principles-and-Parameters theory to propose that null arguments in ASL have multiple analyses, including *pro* under licensing by agreement, and null topics in other configurations (Lillo-Martin 1986).

Starting in the 1990's, more researchers were using generative approaches to sign languages, and a greater variety of sign languages were represented. It's not possible to review all such research here, but mention should be made of a few examples. Ronnie B. Wilbur published a series of works applying generative theory to the analysis of various sentence types in ASL, including information structure-influenced word order variations, clefts, and operator-variable structures (e.g., Wilbur 1991; 1997; Wilbur and Patschke 1999). Wilbur was active in sign language research from the 1970's, and the domain of topic areas she has contributed to is quite impressively broad.

A group of researchers associated with the American Sign Language Linguistic Research Project at Boston University conducted a series of studies cumulating in a book published by MIT Press (Neidle et al. 2000). This work used the spread of non-manual markers as a key to determining hierarchical structure of ASL, and argued that in ASL, the specifier of CP is linearly on the right side, in order to account for sentence-final WH-words in direct questions. This viewpoint was challenged by Petronio and Lillo-Martin (1997), who argued that sentence-final WH-words are focused elements, noting the presence of other focused elements in sentence-final position, and by Quadros (Quadros 1999; Nunes and Quadros 2006), who made a similar argument but used a very different derivation for analogous structures in Brazilian Sign Language (Libras). Debate over the analysis of WH-questions and the position of [Spec, CP] has continued, with an important contribution from Cecchetto, Geraci & Zucchi (2009), who argued that Italian Sign Language (LIS) also has rightward WH-movement, and that it is the unique role of non-manual marking that leads to sign languages using this structure. LIS is different from ASL in its basic word order (SOV) and the pattern of WH-question types allowed is also different, so caution is needed in extending the specifics of the analysis; however, the possibility that the existence of non-manual marking in sign languages leads to different hierarchical structures in comparison to spoken languages is an important consideration.

Since the 1990's, researchers taking a generative approach to sign languages have included a wider range of scholars looking at sign languages other than ASL. One such sign language is Libras, as mentioned earlier (Quadros). There is a very active group of Italian researchers, as already mentioned (including Cecchetto, Donati, Geraci, Zucchi); there are also scholars in Germany (Steinbach), the Netherlands (Pfau), Barcelona (Quer), and Turkey (Kelepir). In addition to many studies of phenomena in specific sign languages, this group has been engaged in various cross-linguistic studies of sign languages, with several very productive collaborative outcomes (Pfau, Steinbach, and Woll 2012; Quer et al. 2017). In Asia, there is an active group at the Chinese University of Hong Kong (Tang), and more recently, several generative scholars in Japan (Kawasaki, Matsuoka).

Currently, as in Stokoe's time, the field of sign linguistics is split between those who adopt formal (typically generative) approaches and those who eschew the distinction between competence and performance (typically cognitive/ functionalist). The field is still small enough that we naturally learn from each other and frequently meet together, although there are now regular periodic conferences devoted to each perspective separately (FEAST: Formal and Experimental Advances in Sign language Theory; and Sign CAFÉ: Cognitive and Functional Explorations in sign language linguistics). Major handbooks, collections, volumes, and reviews are often focused on generative works or at least include them (Neidle et al. 2000; Sandler and Lillo-Martin 2006; Brentari 2010; Pfau, Steinbach, and Woll 2012; Fischer 2017; Quer et al. 2017). All this ensures that Chomsky's influence continues to be felt in sign linguistics.

Given Chomsky's presentation of his conception of the interfaces, it can be presumed that there should be a core of syntactic rules and representations plus words that might be independent of modality; modality factors belong to the external sensory-motor interface. However, this is not to say that there is no influence on the core from an interface. In Chomsky , he spells it out: "The sensory-motor (SM) interface of course requires some kind of ordering (depending on the modality, e.g., different for speech vs. sign)." Then, there is a possibility for modality effects within Chomsky's conceptualization of a language architecture that encompasses both speech and sign.

Consideration of potential modality effects has been a central concern of sign linguists. From the beginning, it was important to establish that sign languages are like spoken languages in many core ways, to give them the legitimacy they were lacking in too many places. And there

are many, many similarities across signed and spoken languages (see Sandler and Lillo-Martin 2006 for a summary). Yet, there are also differences, and these have been of special interest for the light they can shed on where putative universals are deep, and where they are limited to a single modality (Meier, Cormier, and Quinto-Pozos 2002; Lillo-Martin and Gajewski 2014).

Let us consider a frequently-cited example. In sign languages, (co-)reference can be achieved through pointing. A signer may point to a referent who is present in the discourse context (e.g., the addressee), or to a locus in the signing space that is used to represent a referent. These pointing signs are generally considered to be pronouns (although see Koulidobrova and Lillo-Martin 2016 for an argument that at least some are better analyzed as demonstratives). Because the pointing sign usually picks out a specific referent, rather than a class of potential referents such as third-person females (cf. English ‘she’), it is usually unambiguous. Furthermore, there is no way to list all the possible instantiations of the pointing sign plus the location it is directed to. This phenomenon would appear to be a modality effect. Spoken languages do not have an analogous system; they may have means to refer to an element from a relatively small class (e.g., Bantu noun classes), but the sign language forms are unique in ‘pointing’ to a specific referent. Nevertheless, it has been argued that the sign language pronominal system adheres to grammatical principles that have been proposed to govern pronouns, such as Binding Condition B, crossover, etc. (see Sandler and Lillo-Martin 2006). Sign linguists have made various proposals to account for those aspects of the system that make it modality-unique, but many of them do so while attempting to maintain the commonalities between sign language pronominal and demonstrative systems and those of spoken languages (see, e.g., Lillo-Martin and Klima 1990; Steinbach and Onea 2016; Schlenker 2018).

Some researchers have taken the existence of modality effects to be evidence against a strongly modular conception of the language faculty. Sandler (1993) focuses on the Fodorian (Fodor 1983) rather than the Chomskian concept of modularity. She interprets Fodor’s claim that language, as a modular system, is domain-specific, as limiting the language domain to speech (based on the fact that Fodor uses empirical arguments from the study of spoken language). Fodor himself expressed the opinion that ‘domain’ should be interpreted abstractly (Mattingly and Studdert-Kennedy 1991, 369–70), and I agree that the existence of languages in the visual/manual modality is not in itself evidence against the modularity hypothesis (whether Fodorian or Chomskian). Rather, I see the core question of domain-specificity to be whether

specifically linguistic principles are necessary to account for the properties of language (spoken or signed), or whether general cognitive principles suffice. This issue continues to be debated, and inclusion of sign languages in the empirical dataset bearing on it is crucial, to check whether any putative universals that are specific to the language domain are also modality-independent.

### **3. Acquisition and emergence**

Chomsky's linguistic legacy has two primary arms: one in theories of syntax, and the other in theories of language acquisition. Chomsky's strong claim is that the input provided to a young child acquiring their native language is too poor to constitute a complete inductive basis for general cognitive learning principles to succeed. Ergo, some mechanisms for language learning must be domain-specific, and innate. Specifying the content of this 'language acquisition device' has been a central concern of Chomskian linguistics.

Evidence can be gleaned from sign language acquisition that is parallel to that exhibited from the study of spoken languages (cf. chapter 22 of this volume). For example, children may display knowledge of the ungrammaticality of strings that might be expected to be grammatical, given the existence of similar strings in a paradigm – the archetypical case of knowledge in the absence of experience (Crain 1991). Sign language acquisition studies can also be used to test specific theories, such as Chomsky's proposal that acquisition involves selecting the target setting on parameters of cross-linguistic variation (for an example of parameter-setting in ASL, see Lillo-Martin 1991). However, studies of sign language development are also able to contribute uniquely to the question of how children go beyond the input, because of the regrettable fact that many deaf children receive poor quality input, or indeed very little accessible linguistic input of any kind.

First it must be asserted that when children do have fluent, accessible signed input from birth, their course of language development is remarkably parallel to that seen in children developing spoken languages (for overviews, see Chen Pichler 2012; Lillo-Martin 2016; Chen Pichler et al. 2018). So, we shouldn't expect that deafness, or the fact that the language being acquired is manual/visual, would necessarily lead to a radically different path in comparison to hearing children learning a spoken language. What could lead to a different path is striking inadequacy of the input.



Only about five percent of deaf children born in the U.S. have deaf parents who use a sign language (Mitchell and Karchmer 2004). These are the participants in the research briefly described above. However, even for these children, their deaf parents are not likely to have been exposed to a sign language from birth themselves. Although they may have been using ASL as their primary language for many years, if they were later learners they may show irregularities in their use of some grammatical structures (see discussion below). What does the child's acquisition look like if their parents' use of some structure is inconsistent?

This question was investigated in a study by Singleton and Newport (2004). They looked at a domain of ASL grammar that was known to be inconsistently mastered by late learners: the complex morphology of verbs of motion (sometimes known as verbal classifier constructions). They studied one 7-year-old deaf child ('Simon') and his deaf parents, who were late learners of ASL, and the primary providers of input in ASL to their son. What they found was that, as expected, the parents performed rather poorly on their test, like other late learners; in contrast, Simon performed at much higher rates of accuracy, surpassing the scores of his parents, and performing similar to deaf native signer peers.

On the basis of extensive analysis of the response patterns from Simon and his parents, Singleton and Newport conclude that he uses 'frequency boosting' to select the most consistent forms used by his parents, and then regularize them. They describe this process as one that might work in domains outside of language; yet, given that many other possible learning mechanisms would not account for this pattern of results, they endorse the suggestion that "an outcome of this kind would support the claim that children acquire languages at least in part by virtue of innate constraints on the possible form of grammatical rules" (Singleton and Newport 2004, 403).

Simon's input in ASL was degraded due to the delayed acquisition of ASL that his own parents had gone through; yet, he did receive signed input from birth. However, most of the time, when a deaf child is born to hearing parents, they have little to no knowledge of sign languages or the deaf community. They receive advice from doctors and educators, and in many cases they delay providing sign language input, whether because they have consciously adopted a philosophy stressing spoken language and denying sign input, or because they simply need time to go through their own process and start to learn ASL or find alternative input sources for their child. What happens when such learners are eventually exposed to ASL? What do they do in the meantime?

A number of studies have investigated sign language development by late learners: people whose training in spoken language was less than fully successful, who then were exposed to a sign language. Most of these studies consider such learners as late first-language (L1) learners, even though they were exposed to spoken language training through an oral education. Most such studies are conducted with adults, years after the start of their exposure, to see what the outcomes of such delayed L1 acquisition are.

In their comprehensive overview of such studies, Mayberry and Kluender (2018) argue that late L1 exposure to a sign language provides a clear test of the critical period hypothesis: the proposal that there is a critical (or sensitive) period within which language input must be supplied for the typical language acquisition process to proceed. The claim that language development is subject to a critical period is often taken as evidence in support of a Chomskian style nativism. However, it is important to recognize that Chomsky's nativism proposals do not necessarily predict the existence of a critical period; nor would conclusive evidence that there is no critical period be contra-evidence to nativist ideas. The idea of a critical period is compatible with both language-particular, innate learning mechanisms and general-purpose learning mechanisms, either of which could decline or change over time. That said, the results presented by Mayberry and Kluender, and by many others, show clearly that initial exposure to a first language after the first few years of life has long-lasting effects. Mayberry and Kluender also argue that the evidence from second-language acquisition is much more equivocal. They conclude that it is studies of deaf people, who are the only ones likely to experience a delay in accessible first-language exposure, that are crucial to better understand which aspects of language are affected by delays of different lengths.

We've discussed absence of experience as illustrated by grammatical phenomena, and poverty of the stimulus as illustrated by lower-quality or delayed input. What happens during the time that deaf children are experiencing a complete lack of naturally accessible input? Remarkably, they self-generate a system that has many of the characteristics of natural language. Such systems are known as homesign, and they have been intensively investigated by Susan Goldin-Meadow and her colleagues (as summarized in Goldin-Meadow 2003). Goldin-Meadow herself has refrained from making the claim that the results of her research provide support for innate, language-specific knowledge of the type that Chomsky proposes, preferring to characterize the linguistic characteristics she observes as 'resilient' properties. However, the

observations made by her and by others that homesigners produce structures that display characteristics including gesture-internal structure (Brentari et al. 2012), specific patterns of sign order (Goldin-Meadow and Mylander 1998), and recursion (Goldin-Meadow 1982), among many others, indicates that language learners develop not only based on external forces of input, but they also bring to bear powerful language-learning mechanisms that permit them to make use of complex structures found in all natural languages.

In some contexts, homesigners become adults without being exposed to a natural sign language. These adult homesigners may have a limited network of family members and friends with whom they communicate using their self-generated system. While researchers have found that adult homesign systems may display some complexities even beyond those of children, there are still some limitations. For example, a study of adult homesign systems in Nicaragua found that they display evidence of grammatical subjects which can be differentiated from topics (Coppola and Newport 2005). However, although homesigners might use their system to interact with others over many years, when close conversation partners are tested on their comprehension of homesigner productions in the absence of context, they do very poorly (Carrigan and Coppola 2017); and even the lexicons they use are not stable and not strongly shared between the various conversational partners of a single homesigner (Richie, Yang, and Coppola 2014). Based on studies of homesigners, both children and adults, two points can be emphasized (cf. Morford and Wood 2016). First is the observation of ‘resilience’, or the appearance of many language-like characteristics and properties in the absence of experience. Under a Chomskian view, these can be considered manifestations of the language acquisition device. Second, without input from a community that shares a language, learners can only go so far on their own in developing their own language-like system.

Rarely, researchers have the opportunity to observe what happens when isolated homesigners form their own community. When educational programs for deaf children were established in Managua in the 1970’s, deaf children who had previously not had contact with one another came together. Although the programs used the oral method and did not teach using sign language, as could be expected the children used their self-generated systems with each other and over time a natural language emerged. Researchers have been documenting this over some decades (Kegl, Senghas, and Coppola 1999; Senghas 2003), discovering which linguistic properties emerge immediately, and which take one or two cohorts (about 10 years each) for

those who've been using the language for a while to pass it down to the younger, newer community members. Either way, the emergence of Nicaraguan Sign Language has been incredibly rapid, and its grammatical properties have been changing very quickly, in comparison to the methodical pace of language change in established languages. Again, a Chomskian interpretation of these findings would emphasize that core linguistic characteristics following from universal grammar require triggering, but not multiple generations of community interactions to slowly develop.

#### **4. Consequences and implications**

Sign languages, we've seen, are like spoken languages, and they are very different. Although Noam Chomsky himself hasn't attempted to bring data specifically from sign languages into his theories, it seems, especially from the later papers, that the conclusion drawn here would not be surprising for him or under his approach. The generative model, such as its representation in Berwick et al. (2013), hypothesizes both a syntactic component of rules, representations, and words, which could be expected to be largely the same (abstractly) across modalities, but also an external sensory-motor interface, by which phenomena that are tied to a particular modality can be anticipated. This is not to say that anything goes; expected modality effects are constrained under certain views of modularity (for further discussion, see Lillo-Martin 1997; 2002; Lillo-Martin and Gajewski 2014).

This chapter has touched on some of the ways that data from sign languages can bear on generative theoretical proposals. For one thing, the very existence of hierarchy is clearly replicated in sign languages, including the crucial role that concepts such as c-command play, as noted earlier in the context of the spread of non-manual markers. On the other hand, the nature of linearization may be different, given the variety of simultaneous expressions allowed in sign languages (see Kimmelman 2017 for one example). Recent work has also addressed the application of the notions *Merge* and *Agree* in sign languages (e.g., Pfau, Salzmann, and Steinbach 2018; Lourenço and Wilbur 2018). Sign languages have moved into mainstream generative linguistics as languages that should be consulted when universal concepts of language are considered.

Evidence from signers also calls into question the idea that language and other cognitive domains are completely distinct modules. This evidence comes from observations of negative

cognitive effects associated with delayed linguistic access. Connections between early language deprivation and cognitive consequences can be observed in several ways. For example, adult homesigners in Nicaragua do not perform in adult-like ways on tests of Theory of Mind (Pyers and Senghas 2009) or number cognition (Spaepen et al. 2011). Children who have experienced delayed language access may show negative consequences in Theory of Mind (Gale et al. 1996), Executive Function (M. L. Hall et al. 2018), numeracy (Contreras et al. 2018), and other cognitive domains. These observations and others about cognitive functions that rely on healthy language development require a re-thinking of the modularity hypothesis, if modularity is taken to mean that language and cognitive development are entirely independent. Whereas evidence of dissociations between language and cognitive development in extreme cases has been given as evidence for a modular approach (Curtiss 1988), it is also possible that experience with language builds up what Fodor called *horizontal faculties*, including the computational and symbolic resources that are required for successful performance in multiple domains. On the other hand, it's also possible that such a strong view of modularity is simply wrong. Further consideration is required.

Chomsky's insistence on the point that children acquire language under conditions of poverty of the stimulus has been debated in the context of hearing children learning a spoken language (see, for example, articles in a special issue of *The Linguistic Review* 19(1-2), published in 2002). Chomsky's theory doesn't say that no input is required for language to emerge; else how would a child internalize the grammar of the language used around them? Yet, his focus is on the 'ideal speaker/hearer' and the 'idealization to instantaneous acquisition' (Chomsky 1965, and many other works). In the real world, acquisition is not instantaneous, and children (hearing or deaf) require input and a community sharing an accessible language.

Children who cannot access spoken language and are not exposed to a natural sign language are surely in conditions of stimulus poverty. What is remarkable is that some properties of language nevertheless emerge, due to the intense drive to acquire a language. But despite the possibility for developing aspects of a language-like communicative system without accessible input, this kind of stimulus poverty leads to long-lasting negative effects on language and cognitive development. Importantly, whatever theories say about children's linguistic resilience, language deprivation does hurt and must be avoided (W. Hall 2017; M. L. Hall, Hall, and Caselli 2019).

## References

- Berwick, Robert C., Angela D. Friederici, Noam Chomsky, and Johan J. Bolhuis. 2013. "Evolution, Brain, and the Nature of Language." *Trends in Cognitive Sciences* 17 (2): 89–98. <https://doi.org/10.1016/j.tics.2012.12.002>.
- Bolhuis, Johan J., Ian Tattersall, Noam Chomsky, and Robert C. Berwick. 2014. "How Could Language Have Evolved?" *PLoS Biology* 12 (8): e1001934. <https://doi.org/10.1371/journal.pbio.1001934>.
- Brentari, Diane. 2010. *Sign Languages: A Cambridge Language Survey*. Cambridge, United Kingdom: Cambridge University Press.
- Brentari, Diane, Marie Coppola, Laura Mazzoni, and Susan Goldin-Meadow. 2012. "When Does a System Become Phonological? Handshape Production in Gesturers, Signers, and Homesigners." *Natural Language & Linguistic Theory* 30 (1): 1–31. <https://doi.org/10.1007/s11049-011-9145-1>.
- Carrigan, Emily M., and Marie Coppola. 2017. "Successful Communication Does Not Drive Language Development: Evidence from Adult Homesign." *Cognition* 158 (January): 10–27. <https://doi.org/10.1016/j.cognition.2016.09.012>.
- Cecchetto, Carlo, Carlo Geraci, and Sandro Zucchi. 2009. "Another Way to Mark Syntactic Dependencies: The Case for Right-Peripheral Specifiers in Sign Languages." *Language* 85 (2): 278–320. <https://doi.org/10.1353/lan.0.0114>.
- Chen Pichler, Deborah. 2012. "Acquisition." In *Sign Language: An International Handbook*, edited by Roland Pfau, Markus Steinback, and Bencie Woll, 647–86. Boston: de Gruyter Mouton.
- Chen Pichler, Deborah, Marlon Kuntze, Diane Lillo-Martin, Ronice Müller de Quadros, and Marianne R. Stumpf. 2018. *Sign Language Acquisition by Deaf and Hearing Children: A Bilingual Introduction*. Washington, DC: Gallaudet University Press.
- Chomsky, Noam. 1965. *Aspects of the Theory of Syntax*. Cambridge, MA: MIT Press.
- . 2011. "Language and Other Cognitive Systems. What Is Special About Language?" *Language Learning and Development* 7 (4): 263–78. <https://doi.org/10.1080/15475441.2011.584041>.
- Contreras, Jessica, Emily M. Carrigan, Anna Shusterman, and Marie Coppola. 2018. "Language Modality Doesn't Affect Number Concept Development, but Timing of Language Exposure Does: Insights from Deaf Children Acquiring Signed and Spoken Language." In . Boston, MA.
- Coppola, M., and E. L. Newport. 2005. "Grammatical Subjects in Home Sign: Abstract Linguistic Structure in Adult Primary Gesture Systems without Linguistic Input." *Proceedings of the National Academy of Sciences* 102 (52): 19249–53. <https://doi.org/10.1073/pnas.0509306102>.
- Crain, Stephen. 1991. "Language Acquisition in the Absence of Experience." *Behavioral and Brain Sciences* 14: 597–650.
- Curtiss, Susan R. 1988. "Abnormal Language Acquisition and the Modularity of Language." In *Linguistics: The Cambridge Survey: Volume 2, Linguistic Theory: Extensions and Implications*, edited by Frederick J. Newmeyer, 96–116. Cambridge, UK: Cambridge University Press.

- Eastman, Gilbert C. 1980. "From Student to Professional: A Personal Chronicle of Sign Language." In *Sign Language and the Deaf Community: Essays in Honor of William C. Stokoe*, 9–34. Silver Spring, MD: National Association of the Deaf.
- Fischer, Susan D. 1974. "Sign Language and Linguistic Universals." In *Actes de Colloque Franco-Allemand de Grammaire Transformationelle. II. Etudes de Sémantique et Autres*, edited by T Rohrer and N Ruwet, 187–204. Tübingen: Niemeyer.
- . 1975. "Influences on Word Order Change in American Sign Language." In *Word Order and Word Order Change*, edited by Charles Li, 1–25. University of Texas Press.
- . 1990. "The Head Parameter in ASL." In *SLR '87: Papers from the Fourth International Symposium on Sign Language Research*, edited by William H. Edmondson and Fred Karlsson, 75–85. Hamburg, Germany: Signum.
- . 2009. "Sign Language and Linguistic Universals." *Sign Language & Linguistics* 11 (2): 241–64. <https://doi.org/10.1075/sll.11.2.05fis>.
- . 2017. "Crosslinguistic Variation in Sign Language Syntax." *Annual Review of Linguistics* 3 (1): 125–47. <https://doi.org/10.1146/annurev-linguistics-011516-034150>.
- Fischer, Susan D., and Bonnie Gough. 1978. "Verbs in American Sign Language." *Sign Language Studies* 1018 (1): 17–48. <https://doi.org/10.1353/sls.1978.0014>.
- Fodor, Jerry A. 1983. *The Modularity of Mind*. Cambridge, MA: MIT Press.
- Gale, Elaine, Peter A de Villiers, Jill G de Villiers, and Jennie Pyers. 1996. "Language and Theory of Mind in Oral Deaf Children." In *Proceedings of the 20th Annual Boston University Conference on Language Development*, edited by Andy Stringfellow, Dalia Cahana-Amitay, Elizabeth Hughes, and Andrea Zukowski, 213–24. Somerville, MA: Cascadilla Press.
- Goldin-Meadow, Susan. 1982. "The Resilience of Recursion: A Study of a Communication System Developed without a Conventional Language Model." In *Language Acquisition: The State of the Art*, edited by Eric Wanner and Lila Gleitman, 51–77. Cambridge, United Kingdom: Cambridge University Press.
- . 2003. *The Resilience of Language*. New York: Psychology Press.
- Goldin-Meadow, Susan, and Carolyn Mylander. 1998. "Spontaneous Sign Systems Created by Deaf Children in Two Cultures." *Nature* 391 (6664): 279–81. <https://doi.org/10.1038/34646>.
- Hall, Matthew L., Inge-Marie Eigsti, Heather Bortfeld, and Diane Lillo-Martin. 2018. "Executive Function in Deaf Children: Auditory Access and Language Access." *Journal of Speech, Language, and Hearing Research* 61 (8): 1970–88. [https://doi.org/10.1044/2018\\_JSLHR-L-17-0281](https://doi.org/10.1044/2018_JSLHR-L-17-0281).
- Hall, Matthew L., Wyatte C. Hall, and Naomi K. Caselli. 2019. "Deaf Children Need Language, Not (Just) Speech." *First Language* 39 (4): 367–95. <https://doi.org/10.1177/0142723719834102>.
- Hall, Wyatte. 2017. "What You Don't Know Can Hurt You: The Risk of Language Deprivation by Impairing Sign Language Development in Deaf Children." *Maternal and Child Health Journal* 21 (5): 961–965. <https://doi.org/10.1007/s10995-017-2287-y>.
- Hauser, Marc D, Noam Chomsky, and W Tecumseh Fitch. 2002. "The Faculty of Language: What Is It, Who Has It, and How Did It Evolve?" 298: 12.

- Kegl, Judy. 1987. "Coreference Relations in American Sign Language." In *Studies in the Acquisition of Anaphora*, edited by Barbara Lust, II: Applying the Constraints:135–70. Dordrecht: D. Reidel.
- . 2003. "Pronominalization in American Sign Language." *Sign Language & Linguistics* 6 (2): 245–65.
- Kegl, Judy, Ann Senghas, and Marie Coppola. 1999. "Creation through Contact: Sign Language Emergence and Sign Language Change in Nicaragua." In *Language Creation and Language Change: Creolization, Diachrony, and Development*, edited by Michel DeGraff, 179–237. Cambridge, MA: MIT Press.
- Kimmelman, Vadim. 2017. "Linearization of Weak Hand Holds in Russian Sign Language," 33.
- Koulidobrova, Elena, and Diane Lillo-Martin. 2016. "A 'Point' of Inquiry: The Case of the (Non-) Pronominal IX in ASL." In *The Impact of Pronominal Form on Interpretation*, edited by Patrick Grosz and Pritty Patel-Grosz, 221–50. Berlin: Mouton de Gruyter.
- Landar, Herbert. 1961. "Review of 'Sign Language Structure: An Outline of the Visual Communication Systems of the American Deaf' by W.C. Stokoe." *Language* 37 (2): 269–71.
- Liddell, Scott K. 1980. *American Sign Language Syntax*. The Hague: Mouton.
- Lillo-Martin, Diane. 1986. "Two Kinds of Null Arguments in American Sign Language." *Natural Language and Linguistic Theory* 4 (4): 415–44. <https://doi.org/10.1007/BF00134469>.
- . 1991. *Universal Grammar and American Sign Language: Setting the Null Argument Parameters*. Dordrecht: Kluwer Academic Publishers.
- . 1997. "The Modular Effects of Sign Language Acquisition." In *Relations of Language and Thought: The View from Sign Language and Deaf Children*, edited by Marc Marschark, Patricia Siple, Diane Lillo-Martin, Ruth Campbell, and Victoria S. Everhart, 62–109. New York: Oxford University Press.
- . 2002. "Where Are All the Modality Effects?" In *Modality and Structure in Signed Language and Spoken Language*, edited by Richard P. Meier, Kearsy Cormier, and David Quinto-Pozos, 241–62. Cambridge, UK: Cambridge University Press.
- . 2016. "Sign Language Acquisition Studies." In *The Cambridge Handbook of Child Language, 2nd Edition*, edited by Edith Bavin and Letitia R. Naigles, 504–26. Cambridge, UK: Cambridge University Press.
- . 2018. "The Start of a Revolution for Deaf People's Language. Solicited Commentary to Accompany the Reprinting of Stokoe's 1960 Publication, 'Sign Language Structure.'" *Society for ASL Journal* 2 (2): 7–10.
- Lillo-Martin, Diane, and Jon Gajewski. 2014. "One Grammar or Two? Sign Languages and the Nature of Human Language: Sign Languages and the Nature of Human Language." *Wiley Interdisciplinary Reviews: Cognitive Science* 5 (4): 387–401. <https://doi.org/10.1002/wcs.1297>.
- Lillo-Martin, Diane, and Edward S. Klima. 1990. "Pointing out Differences: ASL Pronouns in Syntactic Theory." In *Theoretical Issues in Sign Language Research, Volume 1: Linguistics*, edited by Susan D. Fischer and Patricia Siple, 191–210. Chicago: University of Chicago Press.
- Lourenço, Guilherme, and Ronnie B. Wilbur. 2018. "Are Plain Verbs Really Plain?: Co-Localization as the Agreement Marker in Sign Languages." *FEAST. Formal and*



- Experimental Advances in Sign Language Theory* 2 (0): 68–81.  
<https://doi.org/10.31009/FEAST.i2.06>.
- Mattingly, Ignatius G., and Michael Studdert-Kennedy, eds. 1991. *Modularity and the Motor Theory of Speech Perception*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Mayberry, Rachel I., and Robert Kluender. 2018. "Rethinking the Critical Period for Language: New Insights into an Old Question from American Sign Language." *Bilingualism: Language and Cognition* 21 (5): 886–905. <https://doi.org/10.1017/S1366728917000724>.
- Meier, Richard P., Kearsy Cormier, and David Quinto-Pozos. 2002. *Modality and Structure in Signed Language and Spoken Language*. Cambridge, United Kingdom: Cambridge University Press.
- Mitchell, Ross E., and Michael A. Karchmer. 2004. "Chasing the Mythical Ten Percent: Parental Hearing Status of Deaf and Hard of Hearing Students in the United States." *Sign Language Studies* 4 (2): 138–63.
- Morford, Jill P., and Sandra K. Wood. 2016. "Linguistics: Gestures and Homesigns." In *The SAGE Deaf Studies Encyclopedia*, edited by Genie Gertz and Patrick Boudreault, 611–13. Thousand Oaks, CA: SAGE Publications, Inc.  
<https://doi.org/10.4135/9781483346489.n195>.
- Neidle, Carol, Benjamin Bahan, Dawn MacLaughlin, Robert G. Lee, and Judy Kegl. 1998. "Realizations of Syntactic Agreement in American Sign Language: Similarities between the Clause and the Noun Phrase." *Studia Linguistica* 52 (3): 191–226.  
<https://doi.org/10.1111/1467-9582.00034>.
- Neidle, Carol, Judy Kegl, Dawn MacLaughlin, Ben Bahan, and Robert G. Lee. 2000. *The Syntax of American Sign Language: Functional Categories and Hierarchical Structure*. Cambridge, MA: MIT Press.
- Nunes, Jairo, and Ronice Müller de Quadros. 2006. "Duplication of Wh-Elements in Brazilian Sign Language." In *Proceedings of the 35th Annual Meeting of the North East Linguistic Society*, edited by Leah Bateman and Cherlon Ussery, 463–77. GLSA.
- Padden, Carol A. 1983. "Interaction of Morphology and Syntax in American Sign Language." Ph.D. Dissertation, University of California, San Diego.
- Petronio, Karen, and Diane Lillo-Martin. 1997. "WH-Movement and the Position of Spec-CP: Evidence from American Sign Language." *Language* 73 (1): 18.  
<https://doi.org/10.2307/416592>.
- Pfau, Roland, Martin Salzmann, and Markus Steinbach. 2018. "The Syntax of Sign Language Agreement: Common Ingredients, but Unusual Recipe." *Glossa: A Journal of General Linguistics* 3 (1): 107. <https://doi.org/10.5334/gjgl.511>.
- Pfau, Roland, Markus Steinbach, and Bencie Woll, eds. 2012. *Sign Language – An International Handbook*. Berlin: Walter de Gruyter.
- Pyers, Jennie E., and Ann Senghas. 2009. "Language Promotes False-Belief Understanding: Evidence from Learners of a Nicaraguan Sign Language." *Psychological Science* 20 (7): 805–12.
- Quadros, Ronice Müller de. 1999. "Phrase Structure of Brazilian Sign Language." Ph.D. Dissertation, Porto Alegre: PUC/RS.

- Quer, Josep, Carlo Cecchetto, Caterina Donati, Carlo Geraci, Meltem Kelepir, Roland Pfau, and Markus Steinbach, eds. 2017. *SignGram Blueprint: A Guide to Sign Language Grammar Writing*. Berlin: de Gruyter Mouton.
- Richie, Russell, Charles Yang, and Marie Coppola. 2014. "Modeling the Emergence of Lexicons in Homesign Systems." *Topics in Cognitive Science* 6 (1): 183–95. <https://doi.org/10.1111/tops.12076>.
- Ross, John R. 1967. "Constraints on Variables in Syntax." Ph.D. Dissertation, Massachusetts Institute of Technology.
- Sandler, Wendy. 1993. "Sign Language and Modularity." *Lingua* 89 (4): 315–51.
- Sandler, Wendy, and Diane Lillo-Martin. 2006. *Sign Language and Linguistic Universals*. New York: Cambridge University Press.
- Schlenker, Philippe. 2018. "Visible Meaning: Sign Language and the Foundations of Semantics." *Theoretical Linguistics* 44 (3–4): 123–208. <https://doi.org/10.1515/tl-2018-0012>.
- Senghas, Ann. 2003. "Intergenerational Influence and Ontogenetic Development in the Emergence of Spatial Grammar in Nicaraguan Sign Language." *Cognitive Development* 18 (4): 511–31. <https://doi.org/10.1016/j.cogdev.2003.09.006>.
- Shepard-Kegl, Judy. 1985. "Locative Relations in ASL Word Formation, Syntax and Discourse." Ph.D. Dissertation, Massachusetts Institute of Technology.
- Singleton, Jenny L., and Elissa L. Newport. 2004. "When Learners Surpass Their Models: The Acquisition of American Sign Language from Inconsistent Input." *Cognitive Psychology* 49 (4): 370–407.
- Spaepen, E., M. Coppola, E. S. Spelke, S. E. Carey, and S. Goldin-Meadow. 2011. "Number without a Language Model." *Proceedings of the National Academy of Sciences* 108 (8): 3163–68. <https://doi.org/10.1073/pnas.1015975108>.
- Steinbach, Markus, and Edgar Onea. 2016. "A DRT Analysis of Discourse Referents and Anaphora Resolution in Sign Language." *Journal of Semantics* 33 (3): 409–48. <https://doi.org/10.1093/jos/ffv002>.
- Stokoe, William C. 1960. "Sign Language Structure: An Outline of the Visual Communication Systems of the American Deaf." *Studies in Linguistics* 8: 41.
- . 1990. "An Historical Perspective on Sign Language Research: A Personal View." In *Sign Language Research: Theoretical Issues*, edited by Ceil Lucas, 1–8. Washington, DC: Gallaudet University Press.
- Stokoe, William C, Dorothy Casterline, and Carl Croneberg. 1965. *A Dictionary of American Sign Language on Linguistic Principles*. Washington D.C: Gallaudet College Press.
- Tweney, Ryan, and Harry Hoemann. 1976. "Translation and Sign Language." In *Translation: Applications and Research*, edited by Richard Brislin, 138–61. New York: Gardner Press.
- Wilbur, Ronnie B. 1991. "Intonation and Focus in American Sign Language." In *ESCOL '90: Eastern States Conference on Linguistics*, edited by Y No and M Libucha, 320–31. Columbus, OH: Ohio State University Press.
- . 1997. "A Prosodic/Pragmatic Explanation for Word Order Variation in ASL with Typological Implications." In *Lexical and Syntactic Constructions and the Construction of Meaning*, edited by K. Lee, E. Sweetser, and M. Verspoor, 1:89–104. Philadelphia: John Benjamins.

Wilbur, Ronnie B., and Cynthia Patschke. 1999. "Syntactic Correlates of Brow Raise in ASL." *Sign Language & Linguistics* 2 (1): 3–41. <https://doi.org/10.1075/sll.2.1.03wil>.