Richard P. Meier

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Sign Language Acquisition

Abstract and Keywords

This essay considers the acquisition of sign languages as first languages. Most deaf children are born to hearing parents, but a minority have deaf parents. Deaf children of deaf parents receive early access to a conventional sign language. The time course of acquisition in these children is compared to the developmental milestones in children learning spoken languages. The two language modalities—the oral-aural modality of speech and the visual-gestural modality of sign—place differing constraints on languages and offer differing resources to languages. Possible modality effects on first-language acquisition are considered. Historically, many deaf infants born to hearing parents have had little access to a conventional language. However, these children sometimes elaborate “home sign” systems. Lastly, the role of early experience in language acquisition is considered. Deaf children of hearing parents are immersed in a first language at varying ages, enabling a test of the critical-period hypothesis.

Keywords: sign language, deaf, language acquisition, language modality, children, developmental milestones, home sign, first language, visual-gestural modality

We are often encouraged to think that first language acquisition is effortless for children, and it may well be in comparison to adult acquisition of a second language. Yet we also know that first language acquisition challenges every child: children make characteristic errors on their way toward mastery of their language; mastery does not come for five years or more; and, sadly, some children struggle with developmental language disorders such as Specific Language Impairment.

The varying ways in which deaf children confront and overcome the challenges of first language acquisition raise compelling issues in the study of child language development. A minority of deaf children—generally those born to deaf parents—see a visual-gestural language from the day they are born. That visual-gestural language will be one of the world’s many signed languages of the deaf. What is the time course by which deaf children of deaf parents acquire signed languages? As we’ll discuss, spoken languages and signed languages share many fundamental properties, but they are also shaped and enriched by the particular transmission channel they occupy. How do the constraints and resources of each language modality affect the acquisition process?
Most deaf children—specifically those born to hearing parents—may have no early access to a linguistic system. The capacities of the deaf child’s sensorium mean that, without considerable assistance, he or she is unlikely to acquire a spoken language. The child’s parents may have no knowledge of a signed language and, in some cases, have been actively discouraged from learning one. These deaf children of hearing parents thus confront a serious interruption in the generation-to-generation transmission of language. What does a deaf child do in the absence of perceptually accessible input drawn from a linguistic system?

Eventually, deaf children of hearing parents may encounter a signed language, perhaps when they enter a residential school for deaf children. That encounter may come at varying ages. Can deaf children with delayed access to a first language gain mastery of that language?

The Time Course of Language Acquisition, Given Early Input from a Visual-Gestural Language

Although some hearing communities have auxiliary signed languages (Davis, 2010; Kendon, 1989; Umiker-Sebeok & Sebeok, 1978), every hearing community has a spoken language as its primary language. The ubiquity of spoken languages might lead one to reason that the human language capacity is biased toward spoken languages. On this account, children expect languages to be spoken; we might therefore hypothesize that children who receive input from a signed language would be delayed in their language development.

The children of deaf parents—whether those children are themselves deaf or hearing—receive input from a visual-gestural language from birth. Studies of language development in such children reveal that the acquisition of sign is not delayed; for reviews, see Newport and Meier, 1985; Meier and Newport, 1990; and Emmorey, 2002. By 12 months, signing and speaking children are producing their first sign or word. By 18 to 24 months, signing and speaking children are concatenating two signs or words to form simple sentences. Whether acquiring signed or spoken languages, children typically show early command of the word order patterns of their native language. Children acquiring American Sign Language (ASL) may command the canonical word order patterns of that language by 30 months, but they also show early productivity with regard to rules such as subject-pronoun copy (Padden, 1983) that allow deviation from those canonical patterns (Chen Pichler, 2001, 2012).
Meier (1982, 1987) reported that a morphosyntactic process by which verbs—often highly iconic ones—“agree” with locations associated with their subject and object is acquired between the ages 3;0\textsuperscript{1} and 3:6; see Figure 1 for illustrations of agreeing forms of the ASL verb give.\textsuperscript{2} He argued that this age range was quite similar to the age at which comparable constructions are acquired in spoken languages. Consistent with these results, a longitudinal study of one native-signing child’s acquisition of verb agreement in British Sign Language (BSL) found “strong evidence of productivity” (that is, agreement was used with different verbs, and at least one verb was used with more than one agreement pattern) at 2;11 (Morgan, Barrière, & Woll, 2006: 32). However, there is also suggestive evidence of earlier acquisition of verb agreement: Quadros and Lillo-Martin (2007) report longitudinal data on the acquisition of verb agreement in four children, two acquiring ASL and two acquiring Brazilian Sign Language. They report the children’s use of verb agreement from before age 2, at low frequency, but with few or no errors. They suggest that the different results across studies may be due to problems in defining “which verbs require agreement and in which contexts.”

As in spoken languages, mastery of complex aspects of the grammar of ASL and other signed languages takes time. Just as speaking children may not control certain consonants (e.g., the English /r/) until ages 5 or 6, signing children make errors in handshape through early childhood. A typical error is to substitute an articulatorily simpler handshape for the target (see Meier, 2006, for a review, and for evidence from Brazilian and Finnish Sign Languages, Karnopp, 1994, and Takkinen, 2003, respectively). These errors may reflect the development of fine motor control. However, in “classifier” constructions, handshape errors may persist later yet, through age 9, likely because of the morphological complexity of these signs (Schick, 1990). Another area of relatively late development lies in the use of space to refer to

Figure 1. Forms of the ASL verb give; the citation form is the uninflected, dictionary-entry form of the verb.

[Credit line: Illustration from Meier (1987) is reproduced with permission. Copyright Academic Press.]
absent referents. Sign languages allow signers to associate empty locations in the signing space with such referents. In a story about John and Mary, the signer might associate a location on his left with John and a location on his right with Mary. Then, for purposes of anaphoric reference, the signer may point back to John’s location (just as an English speaker would use he or him to refer back to John). Keeping track of these locations is a complicated task that places substantial demands on the child’s developing memory. In their own narratives, young children sometimes stack several referents onto the same spatial location (Loew, 1984). As Emmorey (2002) concluded in a useful review, errors are generally resolved by age 5, and the system is effectively mastered at age 6.

The only significant controversy regarding the timing of the acquisition of signed languages has been whether there might be some advantage for sign, especially in milestones of very early vocabulary development. Meier and Newport (1990) reviewed the limited evidence then available; that evidence included case studies, as well as longitudinal studies in which deaf parents were asked to keep diaries of the development of their children. For example, Bonvillian, Orlansky, and Novack (1983) followed the development of 11 children (all but one hearing) born into families in which the main language was ASL and in which at least one parent was deaf. On the basis of their review, Meier and Newport concluded that early vocabulary development in speech lagged early vocabulary development in sign by 1-1/2 to 2 months. They also concluded that this advantage for sign did not continue into the two-word period of early syntax.

The best evidence of an advantage for sign in early vocabulary development comes from Anderson and Reilly’s (2002) normative data on 69 deaf children of deaf parents; these data were collected using the ASL version of the MacArthur Communicative Development Inventory (CDI) (Fenson et al., 1994). The CDI is a checklist by which parents report which words or signs their children produce; the CDI for American English has been shown to be a highly reliable instrument for assessing young children’s vocabulary development. The ASL version excludes certain kinds of vocabulary that are likely to appear early in the vocabularies of English-speaking children: for example, onomatopoetic words for animal calls and body-part terms (because most body-part terms in ASL are points to an appropriate location on the signer’s own body). Anderson and Reilly observe that the estimated productive vocabulary sizes of 12–17-month-old deaf signing children exceed those reported for English-speaking children (Fenson et al., 1994). The 12 deaf children they sampled between 12 and 17 months of age had median vocabulary sizes of 62 signs (range 7–107). But this advantage for ASL disappears by 18–23 months.

It is interesting to compare the first 35 English words listed by Fenson et al. (1994) with Anderson and Reilly’s (2002) list of the first 35 ASL signs. Fenson et al.’s list includes 7 interjections (bye, uh oh, hi, ouch, yumyum, nite-nite, peekaboo), 4 onomatopoeias (baabaa, moo, woof, vroom), and 2 body-part terms; the balance were nouns. In contrast, only 2 interjections (bye, no) and 1 or 2 possible gestures (clap, sleep) occur among the first 35 signs. The list of expected early signs otherwise includes nouns (e.g., daddy, mommy, baby,
ball, shoe, milk, cat, dog, the child’s name sign) and a few verbs (eat/food, drink, cry).

Other studies have reported evidence that sign and speech development track very closely: for example, Petitto et al. (2001) reported on the early vocabulary development of a hearing child of deaf parents who was becoming bilingual in French and Langue de Signes Québécoise (LSQ). This boy, who was observed on a roughly trimonthly basis, was first observed to produce a French word and an LSQ sign at 0;10.24. He achieved 50-item vocabularies in each language by 1;5.

Decisions about what constitutes an early lexical item are not easy; comparisons across the two language modalities are difficult. Parents may misjudge babbled utterances as words or signs; so, fathers of English-hearing children may be quick to judge the babble [dædæ] to be a word. The same could happen in sign, such that a manual babble (Petitto & Marentette, 1991; Cheek, Cormier, Repp, & Meier, 2001) that is made with repeated opening and closing of the hand might mistakenly be identified as a sign such as ASL milk (Petitto, 1988). All children produce communicative gestures, and those sometimes may be judged to be signs; in contrast, estimates of the spoken word vocabularies of hearing children are not affected by the gestural vocabularies of those children (Volterra & Iverson, 1995). First words or signs may not be used in sophisticated ways. On relatively stringent criteria for what constitutes a word that demand cognitively sophisticated usages of a word or sign, there are no known differences between the developmental milestones of signed and spoken languages (Volterra & Caselli 1985; Petitto 1988, Bonvillian & Folven 1987). On the other hand, we have seen that some concepts that are encoded as words by young speaking children (e.g., words for animal noises or for body-parts) are not included in estimates of early vocabulary size in infant signers (Anderson & Reilly, 2002).

In conclusion, there is no evidence for delay in the acquisition of sign. Instead, to the extent that there is any evidence of a difference in the timing of language acquisition between sign and speech, the advantage goes to sign. The broad similarities in the acquisition of sign and speech are evidence of the fundamental plasticity of the human language capacity. That capacity is sufficiently plastic that language can emerge in either of at least two modalities and will do so on approximately the same developmental schedules.
The overarching claim that signed and spoken languages are acquired on much the same schedule does not mean that there are no effects of modality. The limited evidence that first signs may emerge earlier than first words suggests an effect of language modality very early in language acquisition. Newport and Meier (1985: 889) noted four possible explanations for the early emergence of first signs: the iconicity of signs; earlier maturation of the motoric or perceptual systems that subserve sign; the greater perspicuity of signs, due perhaps to their large size or slow rate of production; and the “greater recognizability” to parents or experimenters of first signs than of first words. Newport and Meier were pessimistic that iconicity could be a major factor, in part because many early signs are not iconic (e.g., the ASL sign mother; see Figure 2) and because the iconicity of some early-acquired ASL signs may not be accessible to children. For example, recognizing the iconicity of the noun milk—a rough mime of milking a cow—depends on knowledge of the dairy industry that is available to adult second language learners but likely not to infants.

Signs and words share many linguistic properties—for example, signs and words are conventional form-meaning pairings (Saussure, 1916) that must be learned by the speakers or signers of particular languages. To acquire a word or a sign, a child must learn its articulatory form (e.g., the English phonetic form [kæt]), must acquire the concept in question (e.g., the category of felines), and must map the concept to the phonetic form. However, signs and
words also differ in ways that may have implications for the structure of signed languages and/or their acquisition (Meier, 2002, 2012). For example, because of the large size of the manual articulators, signs are slower to produce than words (Bellugi & Fischer, 1972; Klima & Bellugi, 1979; for discussion of the duration of spoken versus signed syllables, see Wilbur & Nolen, 1986, and Dolata, Davis, & MacNeilage, 2008). The relatively slow rate of sign articulation may push signed languages toward morphological structure that is tiered in its organization, unlike the sequential structure of prefixation and suffixation that is favored in spoken languages. Some of the articulatory factors that impinge on a young child’s production of signs or words may be unique to a particular modality (e.g., signing involves the coordination of the two hands, meaning that children must learn, in the production of many signs, to inhibit the movement of the nondominant hand), whereas other motoric factors (e.g., a tendency in infants toward repetitive, cyclic productions like “baba”) characterize early phonological development in both language modalities (Meier, Mauk, Cheek, & Moreland, 2008).

**Perspective-taking and the form of signs**

![Figure 3. The ASL signs tuesday (left) and toilet (or bathroom) differ in palm orientation. These signs are also distinguished by movement: the sign tuesday has a small, circular movement, whereas toilet has a back-and-forth movement.](Credit line: Photographs copyright RPM.)

The appearance of a sign can vary greatly as a function of the individual’s perspective on that sign; the problem for children is that they must learn to produce signs as they appear from the signer’s perspective, not from their own perspective as addressees. For example, the ASL signs tuesday and toilet differ in palm orientation; tuesday is produced with the palm toward the signer, whereas toilet is produced with the palm out; see Figure 3. These signs also differ in movement, with tuesday having a small circular movement, whereas toilet has a back-and-forth movement. When a child who is seated opposite his/her parent sees the sign tuesday, that child sees the back of the parent’s hand; however, when the child produces the sign correctly, the child must have her own palm in view. Learning to make signs correctly (and thereby avoiding errors that could be embarrassing for an adult second-language learner) requires that children perform a spatial transformation on the input that is presented to them; no such transformation is required in the
acquisition of spoken words. Making this transformation does not appear to be
difficult for typically developing children, but it does appear to be a problem
for native-signing children with autism spectrum disorder (ASD). Shield and
Meier (2012) suggest that a deficit in self/other mapping (Rogers &
Pennington, 1991; Williams, Whitren, & Singh, 2004)—that is, a deficit in the
ability to map the movements of others onto one’s own body—leads signing
children with ASD to produce a class of palm orientation errors that have no
counterparts in the phonological development of hearing children with ASD.

**Iconicity**

The visual-gestural modality of signed languages has greater resources for
iconic representation than does the oral-aural modality of spoken languages.
Aside from onomatopoetic representations of sounds (e.g., *bow-wow, meow*),
the mapping between form and meaning in the words of spoken languages is
seldom imagistic; rather, form-meaning mappings are typically arbitrary. In
contrast, the movement of the two hands in the transparent, three-
dimensional signing space allows signed languages to represent the shape and
movement of objects imagistically. This being said, signed languages also have
fully arbitrary signs; the ASL sign *mother* (Figure 2) is an example of a sign
that is almost completely arbitrary. Whether in sign or speech, the mapping
between form and meaning need not always be arbitrary, but all languages
must allow arbitrary form-meaning mappings in order to have lexical items for
abstract, nonimageable concepts (Meier, 2002). Crucially, whether arbitrary or
imagistic, form-meaning mappings in signed and spoken languages are
conventional within particular linguistic communities.

The role of iconicity in early vocabulary development in signed languages has
been a longstanding issue. Meier et al. (2008) asked whether young signing
children were little mimes who would err by making ASL signs more iconic
than the target sign in the adult language. They followed the signing of four
deaf children of deaf parents; those children ranged in age from 8 to 17
months over the course of the study. The preponderance of children’s sign
productions were judged, by adult raters, to be as iconic as the adult target or
less iconic than the adult target. Only a small number (less than 5%) of
children’s productions were judged to be more iconic. Meier et al. concluded
that children’s errors were best explained by articulatory or motoric factors,
not by a drive to enhance iconic representation.

What about the composition of children’s early sign vocabularies? Orlansky
and Bonvillian (1984) concluded that iconic signs are not overrepresented in
the vocabularies of infants. Their evidence came from a diary study of 13
children (12 hearing, 1 deaf) of deaf parents. More recent results on British
Sign Language (Thompson, Vinson, Woll, & Vigliocco, 2012) show effects of
iconicity on early vocabulary development: the deaf parents of 31 deaf
children, aged 11–30 months, were asked to complete the BSL version of the
MacArthur Communicative Development Inventory (Woolfe, Herman, Roy, &
Woll, 2010). When doing this, parents work through a list of signs and indicate
which ones their child comprehends or produces. Thompson et al. focused on
89 signs from the inventory, each of which had been previously rated for
iconicity and for phonological complexity. Both younger (11–20 month olds)
and older children (21–30 month olds) comprehended and produced more of the iconic signs than of the noniconic signs. This was particularly true of the older age group. Phonological complexity interacted with age; younger signers produced less complex signers than did the older children.

There are different kinds of iconicity. Meier (1982, 1987) noted that, in the verb agreement system of ASL, certain forms of an iconic verb such as GIVE are mime-like, whereas other verb forms are like a map or diagram (a “spatial analogue”) of the event being described; again see Figure 1. So, give\(^{[1>2]}\) “I give you” is a mime of an action of giving, but give\(^{[2>1]}\) is not (although it does provide a rough map of the participants’ relative locations and of the direction of transference). Meier asked whether children acquiring ASL are guided by either type of iconicity or whether they were sensitive to the morphological structure of agreeing verbs; he argued that longitudinal data, as well as the results of an elicited imitation study, supported the morphological account. More recently, Meir, Padden, Aronoff, and Sandler (2013) have also analyzed verb agreement in ASL and Israeli Sign Language in terms of competing systems of iconic representation; they distinguished between verb forms in which the signer’s body represents the subject of the verb versus verbs in which in which the body represents first person. Ortega, Sümer, and Özyürek (2014) examined pairs of near-synonyms in Turkish Sign Language (TID) in which one member of the pair represents the shape of an object (“perceptual signs”—e.g., a sign for “bed” that represents the shape of a typical bed) and the other member represents an action performed with that object (“action signs”—e.g., a sign for “bed” that represents the action of placing one’s head on a pillow). Although adults tended to prefer the perceptual alternate, preschoolers and school-aged children—as well as parents when addressing their children—preferred the action sign. Thus, at least in TID, the vocabularies of children—as well as the vocabularies that parents use—may differ from the adult-to-adult language in their favored patterns of iconicity.

**Indexicality**

Click to view larger
Figure 4. Personal pronouns in ASL. Note that ASL pronouns are not marked for gender or case. The pronoun glossed here as you is a point to the addressee; the point glossed as him/her can be directed to the actual location of the referent (if present) or it can be directed to an empty location in the signing space that has been associated with the referent.

In signed languages, the mapping between form and meaning can be motivated by iconicity or indexicality. One class of motivated signs includes those signs that function as pronouns in ASL and other signed languages. These signs do not look like their referents, but instead point to their referents or to locations associated with their referents; see Figure 4. These pointing signs are indexic and, as such, they share many properties with the gestural pointing that accompanies spoken languages (Liddell, 2003; Johnston, 2013; Meier & Lillo-Martin, 2013). The motivated properties of sign pronouns account for their relative uniformity crosslinguistically, unlike the great diversity in the morphology of spoken pronouns (McBurney, 2002).

In spoken languages, pronouns are problematic because they shift in their reference as a function of who is speaking and who is listening; I use I/me to refer to myself and you to refer to my addressee. But if my addressee takes the floor, she refers to herself as I/me and to me as you. A minority of children who are acquiring spoken languages are said to “reverse” first- and second-person pronouns; such children may use the pronoun I/me in contexts that call for you, and may use you in contexts calling for I/me (Chiat, 1982; Oshima-Takane, 1992). Do such errors arise if the mapping between the form of a pronoun and its referent is transparent?

The answer is yes. Despite their transparency, some children make errors in the acquisition of signed pronouns; these errors appear to be of the same type as those reported from hearing children. Petitto (1987) reports a longitudinal study of two native-signing deaf girls (Carla & Kate, ages 0;6 to 2;3) who were acquiring ASL. In their spontaneous behavior from 10 and 12 months, respectively, Carla and Kate showed early usage of points to people, including self-reference. But in a middle period in their acquisition of pronouns (from 12 months for Kate and 15 months for Carla, until 18 months for both girls), pointing to people dropped out. During this period, the children used nouns such as mother and father in contexts in which a pronoun would have been appropriate; Kate twice used the noun girl to refer to herself. From 21 to 23 months, points to people reemerged in these children’s signing, but with many errors in usage. In particular, Kate consistently used the pronoun you to mean “me” and did not use the pronoun me at all. This pattern appeared in a small number of spontaneous tokens, but in a substantially larger number of elicited tokens. The second child, Carla, also showed evidence of pronoun errors, but her errors were less systematic than Kate’s. Finally, from 25 months (in the case of Carla) and 27 months (in the case of Kate), these children used first-, second-, and third-person pronouns correctly. Petitto interprets the data from Kate as indicating that, at 21–23 months, she did not know that you is an indexic form; instead Kate treated you as a name for herself, consistent with the suggestion that the preponderance of usages of you that she witnessed referred to her. Jackson (1989) and Pizzuto (1990) have also reported errors in
pronoun usage, but, as in the acquisition of spoken languages, not all children produce such errors; thus a case study of one child’s acquisition of Greek Sign Language found no errors of this type (Hatzopoulo, 2008).

Pronoun reversals are a characteristic of the speech of children with autism spectrum disorders (Tager-Flusberg, 1994). To date, no reversals have been identified in the language of native-signing deaf children with ASD, but, whether this result is due to modality differences or sampling problems is unclear. However, pronoun avoidance has now been reported in both speaking and signing children with ASD; see Jordan (1989) for discussion of this phenomenon in English-speaking children with ASD. In a task in which school-age children are asked to identify a picture of themselves or of their addressee, children with ASD tend to avoid pronouns in favor of names. This is true whether the children are native speakers of English (Lee, Hobson, & Chiat, 1994) or native signers of ASL (Shield, Meier, & Tager-Flusberg, 2015). The morphological opacity or transparency of pronouns does not appear to be at issue for these children; rather, Shield et al. speculate that differences in self-concept may lead children with ASD to prefer names over pronouns.

**Language Development without a Language Model**

The previous sections focused on deaf children born into deaf, signing families. However, deaf children of deaf parents may constitute only 4% of the deaf population in the United States (Mitchell & Karchmer, 2004). Instead, the vast majority of deaf children are born to hearing parents. In the past, deaf children of hearing parents typically received very limited linguistic input in infancy; indeed, even in the early 1990s, their hearing loss was often not identified until an average age of about 2-1/2 (National Institutes of Health Consensus Development Conference Statement, 1993), although this has changed with the advent of neonatal hearing testing. When children’s deafness was recognized, their parents were often discouraged from signing or gesturing to them. Moreover, whatever speech training such a child received may have been ineffective. What would children do in such a situation? Did they have any systematic means to communicate?

Susan Goldin-Meadow and her colleagues undertook longitudinal studies of 10 deaf children, from as young as 1;4 to as old as 4;6, who were born into otherwise hearing families in Philadelphia and Chicago; see Goldin-Meadow and Mylander (1990) and Goldin-Meadow (2003) for overviews. The language-like gestural communication of these children is called “home sign” and the children themselves are sometimes known as “home signers.” These home signers had a vocabulary of gestures, some drawn from the nonlinguistic gestures that their parents produced, but most innovated by the children themselves. Two classes of gestures were prevalent: pointing gestures and “characterizing signs.” An example of a characterizing sign is one child’s (David’s) gesture for “snow,” which was a wiggling movement of the fingers, with the hand (palm down) held slightly above his head; another example is a
two-fisted mime of breaking an object (e.g., a stick) in half. The fact that these characterizing signs were iconic meant that they could be understood by their parents and other interlocutors. Without access to the resources for iconic representation that are available in the visual-gestural modality, it is hard to imagine how these children could have developed an effective vocabulary; see Fay, Lister, Ellison, and Goldin-Meadow (2014) for an experimental probe of the efficacy of vocalization versus gesture in adult innovation of a communication system in a laboratory situation.

Figure 5. A gestural sentence produced by David (3;5), a home signer. David was holding a toy in his hand as he gestured. Here David produces the string that (to tray of food) eat you (to SGM). This utterance exemplifies David’s reliable tendency to order patient gestures before act gestures. This illustration is based on video made available to RPM by Susan Goldin-Meadow.

Crucially, the home signers combined gestures to form simple multi-gesture strings. Such sentences displayed statistically reliable ordering tendencies: gestures encoding a patient (that is, the object acted upon in an English sentence such as “Bugs Bunny ate the carrot.”) reliably preceded the gesture encoding the act; see Figure 5. For verb-like gestures that encoded transitive actions, Goldin-Meadow and her colleagues examined whether the patient or agent was more likely to be expressed in a two-sign string; all the children preferred to encode the patient. What was the source of these patterns? Not the children’s parents: the parents were less likely to combine gestures than were the children, were later to do so (Goldin-Meadow & Feldman, 1977), and did not shape their children’s patterns through their responses to the children (Goldin-Meadow & Mylander, 1983). Interestingly, the same ordering tendencies and the same production probabilities held for home signers in Taiwan, but the Taiwanese mothers—unlike the American mothers—showed some of the same patterns as their children. Why? Likely because these mothers had learned from their children (Goldin-Meadow & Mylander, 1998).

A series of studies with adult nonsigners suggested to Goldin-Meadow and her colleagues that these ordering patterns may be cognitively natural. Adult monolingual speakers of four different languages (English, Spanish, Turkish, and Chinese) were asked to describe transitive actions in a task in which they could not use speech; they were instructed to only use gesture (Goldin-Meadow, So, Özürek, & Mylander, 2008). The adults used SOV (agent-patient-act) word order in their gestures. Thus, like the home-signing children, these adults placed the patient before the verb, even though only one of the subject groups (the Turkish speakers) had this word order as the predominant word order in their native language. Interestingly, another group of adults,
who were speakers of these same languages, displayed the same ordering
regularities in a task in which they stacked transparencies to illustrate these
transitive actions. These ordering tendencies emerged even though this task
was not a communication task; there was no interlocutor. In a separate study
in which two hearing adults participated in nine gesture-only sessions over a
period of weeks (Goldin-Meadow, Yalabik, & Gershkoff-Stowe, 2000), these
participants each showed the same production probabilities as the home
signers; that is, they were much more likely to encode the patient than the
agent in transitive two-gesture strings.

In conclusion, home-signing children can, as individuals, elaborate language-
like structure, including a vocabulary, a simple syntax, and other linguistic
properties that Goldin-Meadow (2003: 186) has termed resilient; resilient
properties emerge, on her view, even when a child lacks a conventional
linguistic model. At this point in time, we can’t see how far these children
could progress with their home sign systems, because—at least in countries
like the United States—the development of home sign systems is short-
circuited by contact with ASL or English or some other established language.
But, in Nicaragua, it has been possible to examine the home sign systems of
adolescents and young adults (Coppola & Newport, 2005). Home sign
systems, whatever the age of the user, may be one contributor to the
development of Nicaraguan Sign Language, a new language that has
developed since the late 1970s (Kegl, Senghas, & Coppola, 1999).

The Early Years Matter

In 1967, Eric Lenneberg hypothesized that language acquisition must occur
during a “critical period.” The critical period is a maturationally determined
period during which children can successfully acquire language, but outside of
which language acquisition is likely to be difficult or incomplete. For
Lenneberg, this period extended from roughly age 2 until puberty. Critical
periods have been hypothesized for various behaviors in various organisms,
for example imprinting in ducklings and attachment in rhesus macaques.
Direct tests of the critical period hypothesis for language are difficult to
achieve. Lenneberg’s hypothesis pertains most fundamentally to first language
acquisition; however, in the hearing population it is impossible to identify
children who do not have early exposure to language, except for tragic cases
of abused or neglected children, such as Genie (Curtiss, 1977).

Delayed exposure to a first language

As we have seen, deaf children of hearing parents face an interruption in the
generation-to-generation transmission of language. An unknown proportion of
these children innovate a home-sign system. Later, when they enter school,
they may gain their first effective exposure to a conventional language. Elissa
Newport (1990), along with her colleague Ted Supalla, administered a battery
of comprehension and production tests to native, early, and late learners of
ASL, all of whom had attended a single residential school for the deaf, the
Pennsylvania School for the Deaf. All of these signers considered ASL to be
their primary language, and all had been signing for at least 30 years. Native learners had deaf parents; early learners gained their first exposure to ASL at ages 4–6, when they entered the residential school; and late learners gained their first exposure after age 12, again, when they entered the residential school. All subjects performed very well on a test of ASL word order; their performance was unrelated to the age at which they were exposed to ASL. But scores on the production and comprehension of ASL morphology were strongly related to age of exposure to ASL; native learners performed better than early learners, who in turn performed better than late learners. This pattern of results is consistent with Genie’s acquisition of English, which began in adolescence. Genie was generally successful in her use of English word order, but showed very limited acquisition of the inflectional morphology and function words of English (Curtiss, 1977).

Rachel Mayberry has a series of important papers looking at what language learning and processing in the deaf can tell us about a critical period for first language acquisition. Mayberry and Eichen (1991; also see Mayberry & Fischer, 1989) looked at memory for ASL sentences as a function of age of acquisition; similarly to Newport (1990), participants were first exposed to ASL at birth, in childhood upon entry to a residential school for the deaf, or in late childhood (ages 9–13, again upon entry to a residential school). Accuracy in recall of ASL sentences declined with age of exposure. Moreover, the kinds of errors made by native and late learners differed, such that native learners made errors that were semantically related to the target sign, whereas late learners made errors suggestive of very shallow processing (e.g., repeating the sign sleep as the phonologically similar, but semantically unrelated sign and). A more recent paper using fMRI (Mayberry, Chen, Witcher, & Klein, 2011) reports patterns of brain activation in deaf adults that are linearly related to age of acquisition of ASL.

Crucially, early exposure to a first language, whether spoken or signed, yields better acquisition of a second language, whether that language is spoken or signed. Mayberry and Lock (2003) demonstrated, using a test of grammaticality judgments, that deaf individuals with exposure in infancy to ASL and hearing individuals with exposure in infancy to one of a variety of spoken languages did equally well on learning English syntax during the school years; both groups had used English for over 12 years at the time of testing. But deaf individuals with limited early language exposure did significantly worse on acquiring English. Interestingly, late-deafened individuals who had early exposure to English scored significantly better on a test of the acquisition of ASL than did congenitally deaf individuals who had little or no language exposure prior to entering school (Mayberry, Lock, & Kazmi, 2002). Cormier, Schembri, Vinson, and Orfanidou (2012) found a linear relationship between age of acquisition of BSL and performance on a grammaticality judgment task for deaf participants who had first been exposed to BSL from birth through age 8. But this relationship did not exist for deaf participants who were later learners of BSL; Cormier et al. argue that these later learners may have scaffolded their acquisition of BSL on their earlier acquisition of English, as assessed by tests of reading ability.
Early linguistic experience may affect aspects of cognitive development. Rich, early language exposure—particularly exposure that is sufficient to allow children to acquire complement clauses in which the truth value of the embedded clause is independent of the truth value of the full sentence, as in *John said (or believed) that the Moon is made of green cheese*—may be necessary for the timely development of theory of mind (de Villiers & de Villiers, 2000). Theory of mind is the understanding that other individuals may have different beliefs than one's own. Schick, de Villiers, de Villiers, & Hoffmeister (2007) argue that, because the linguistic input to deaf children of hearing parents may be impoverished, these children are delayed in the development of theory of mind. In contrast, deaf children of deaf parents develop theory of mind on the same schedule as hearing children born into hearing families.

In sum, deaf children constitute the only sizeable population of children who may have delayed exposure to a first language. As such, language acquisition among deaf children constitutes a crucial test of the critical period hypothesis. The evidence to date shows that early experience is indeed critical; even after years of experience, congenitally deaf individuals who gained their first exposure to a conventional language in late childhood or in adolescence show significant limitations in linguistic knowledge and performance, as compared to individuals who were immersed in a sign language from infancy. Moreover, the development of cognitive abilities such as theory of mind may be late in children with delayed or impoverished early linguistic exposure. These findings have important policy implications for parents, educators, and clinicians; see, for example, Humphries, et al. (2012).

**Emergent signed languages**

Young children may be uniquely successful, not only in learning language, but in adding structure to an emergent language. We have already seen that deaf children of hearing parents produce home sign systems with many language-like properties; individual children—not their parents—appear to be the source of the structure in these systems. Singleton and Newport (2004) looked at the language of a 7-year old deaf boy whose only signed input came from deaf parents who were late learners of ASL and whose knowledge of ASL, vis-à-vis native signer norms, was quite limited. Yet, despite his limited input, this child’s performance on measures of ASL performance approximated native signer levels in many respects. Again, this evidence suggests that individual children can add structure to input that is in some ways deficient.

Nicaraguan Sign Language (NSL) has developed just since the late 1970s; prior to that time, there appears to have been no deaf community and no sign language in Nicaragua (Polich, 2005). NSL has emerged largely independently, with minimal influence from outside the country. Senghas and Coppola (2001) examined the signing of the first and second “cohorts” to enter the residential school for the deaf in the capital city of Managua, with first cohort signers having entered the school before 1983 and second cohort signers entering after 1983; at the time of testing, all subjects had at least 4.5 years of exposure to the language. On three measures of linguistic performance—the mean number of spatial modulations per verb, the
proportion of spatial modulations used for shared reference, and a measure of fluency—second cohort signers exceeded first cohort signers. (See Lillo-Martin & Meier, 2011, for recent discussion of these kinds of spatial modulations as used in a long-established sign language, ASL, where they have been variously referred to as indicating, directional, or agreeing verbs.) Senghas and Coppola (2001: 328) suggest that the resources available to first cohort signers “were evidently insufficient for the first-cohort children to stabilize on a fully-developed language before entering adulthood.”

Senghas and Coppola (2001) noticed a second pattern within their results. Signers who had entered the community as young children did best: signers who were exposed to NSL before age 10 produced more spatial modulations per verb than did late-exposed signers. Moreover, second-cohort signers who were exposed before 6;6 produced more spatial modulations per verb than did their early-exposed counterparts in the first cohort. Second-cohort signers who were exposed before age 10 were also more likely to use spatial modulations for shared reference than were their counterparts from the first cohort.3 And signers who were exposed before age 10 appeared to be more fluent than later-exposed individuals. These results show that signers who entered the Managua school as children led the development of Nicaraguan Sign Language.

Conclusion

The signed languages of the deaf are an extraordinary expression of human cultural and linguistic diversity. Languages such as Australian Sign Language (Johnston & Schembri, 2007), Israeli Sign Language (Meir & Sandler, 2007), BSL (Kyle & Woll, 1985), and ASL (Klima & Bellugi, 1979; Padden & Humphries, 1988) are vital minority languages within their respective nations. This alone is sufficient reason to explore the acquisition of signed languages by children who are born into—and/or educated within—signing communities. As we have also seen in this article, signed languages and deaf communities present unusual research opportunities to scientists who work in tandem with those communities. Signing children—whether deaf or hearing, whether from deaf- or hearing-parented families—exploit a visual-gestural modality that has differing constraints and offers differing resources than the familiar oral-aural modality of spoken languages. Moreover, deaf children born into nonsigning families regularly confront a break in the generation-to-generation transmission of language that is rarely faced by hearing children. By observing and understanding signing children, scientists can address fundamental questions about the human capacity for language that could not be addressed if the perspective of linguistics and of the language sciences were limited to languages that are spoken and heard.
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Notes:

(1) The notation “3;0” means that the child’s age was three years and zero months. The precise age of three years, zero months, and five days is indicated as 3; 0,5.

(2) The English labels for ASL signs appear in small caps.

(3) The use of spatial modulations for shared reference is an index of the use of space for discourse cohesion. If a signer reused a spatial location in order to refer back to a referent that had been previously associated with that location in space, this was considered shared reference.

Richard P. Meier

Richard P. Meier, Department of Linguistics, The University of Texas at Austin

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