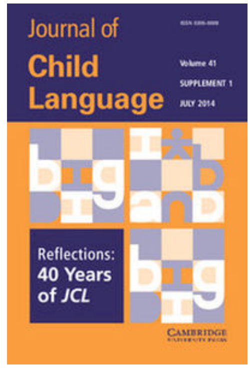

In search of resilient and fragile properties of language

SUSAN GOLDIN-MEADOW

Journal of Child Language / Volume 41 / Supplement S1 / July 2014, pp 64 - 77
DOI: 10.1017/S030500091400021X, Published online: 15 July 2014

J. Child Lang. **41** (S1) (2014), 64–77.
doi:10.1017/S030500091400021X

In search of resilient and fragile properties of language*

SUSAN GOLDIN-MEADOW
University of Chicago

ABSTRACT

Young children are skilled language learners. They apply their skills to the language input they receive from their parents and, in this way, derive patterns that are statistically related to their input. But being an excellent statistical learner does not explain why children who are not exposed to usable linguistic input nevertheless communicate using systems containing the fundamental properties of language. Nor does it explain why learners sometimes alter the linguistic input to which they are exposed (input from either a natural or an artificial language). These observations suggest that children are prepared to learn language. Our task now, as it was in 1974, is to figure out what they are prepared with – to identify properties of language that are relatively easy to learn, the RESILIENT properties, as well as properties of language that are more difficult to learn, the FRAGILE properties. The new tools and paradigms for describing and explaining language learning that have been introduced into the field since 1974 offer great promise for accomplishing this task.

In, 1974, when the first issue of the *Journal of Child Language* was published, the most common approach to studying language learning was to do nothing more than watch and listen as children talk – a timeless approach that worked well then, and has continued to yield new insights. But a great deal has changed since 1974 in terms of how we describe and, more importantly, how we explain language learning. Although there is disagreement among the theories offered to explain how children learn language, all modern-day accounts accept the fact that children come to language learning prepared to learn. The disagreement lies in what each theory takes the child to be prepared with: a general outline of what

[*] Supported by R01DC00491 from the National Institute of Deafness and Other Communicative Disorders and by P01 HD 040605 from the National Institute of Child Health and Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. Address for correspondence: Susan Goldin-Meadow, University of Chicago, Department of Psychology, 5848 South University Avenue, Chicago, IL 60637. tel: 773-702-2585; e-mail: sgm@uchicago.edu

language is? a set of processes that will lead to the acquisition of language (and language alone)? a set of processes that will lead to the acquisition of any skill, including language?

I focus here on the tools and paradigms that have led to progress since 1974 in answering these questions. In particular, I focus on tools that have helped us identify properties of language that children find relatively easy to learn, properties that I have previously called RESILIENT (Goldin-Meadow, 1982, 2003), and properties of language that children find more difficult to learn, the FRAGILE properties of language that require more of the learner and/or the learning environment to be developed.

ADVANCES IN DESCRIBING WHAT CHILDREN KNOW ABOUT LANGUAGE

Observing more languages

The typical study in 1974 described a small number of children, and those children were, for the most part, white English-learners from middle- to upper-class homes. One significant change that has taken place is that we now study language learning in children from a wide range of families representing the demographic diversity within the United States (e.g. Pan, Rowe, Singer & Snow, 2005), beyond the United States and, importantly, beyond English. For example, during the 1970s, 80% of data-oriented articles in the *Journal of Child Language* focused exclusively on English. By 1990, the percentage had dropped to 57% (Slobin, 1992) and some aspect of language acquisition had been explored in thirty-six different languages.

What has studying children who are learning different languages taught us? Overall, we find that children graciously accept the differences in the languages to which they are exposed. They learn the particular properties that their language presents, and they do so from the earliest stages. But there are times when children veer from the input they receive, and these times are interesting because they provide insight into the preferences children bring to language learning, preferences with respect to both meanings and forms.

For example, regardless of the language they are learning, children begin by grammatically marking roles in highly transitive activities, that is, in events where an agent brings about a physical and perceptible change of state in a patient, either by means of direct body contact or an instrument (Slobin, 1985). In Russian, accusative inflections must be placed on all words that fill the direct object slot, regardless of the type of event conveyed. But children first use the accusative inflection ONLY in sentences describing manipulative physical actions (giving, putting, throwing; Gvozdev, 1949, as described in Slobin, 1985). Similarly, in Kaluli, an ergative language in which an inflection must be placed on the agent in all transitive events, children first use the ergative inflection ONLY in sentences describing concrete, manipulative actions (Schieffelin, 1985). These highly transitive activities constitute a "central semantic organizing point for grammatical marking" (Slobin, 1985, p. 7) – a starting point for the language learning child and a potential resilient property of language.

In addition to meanings that appear to be privileged in the early stages of child language, there are forms that children find easy to incorporate into their language. For example, children combine words into strings that follow particular ordering patterns, even when the language they are learning allows relatively free word order (Bates, 1976; MacWhinney, 1977; Slobin, 1966). We can see the preferences children bring to language learning when we look at how they take in, and change, the languages of the world.

Observing more children from a wider range of families

Because transcribing and analyzing child talk is so labor-intensive, each individual language acquisition study in 1974 typically focused on a small number of children interacting with their primary caregiver at home. Advances in computer technology have made it possible for researchers to share their transcripts of child talk via the computerized Child Language Data Exchange System (CHILDES; MacWhinney, 1995). A single researcher can now call upon data collected from spontaneous interactions in naturally occurring situations across a wide range of languages, and thus test the robustness of descriptions based on a small sample.

In addition to increasing numbers by compiling data from independently conducted case studies, there now exist several studies containing large numbers of children followed longitudinally (e.g. Hart & Risely, 1995; Pan *et al.*, 2005). For example, our team at the University of Chicago has studied sixty-four typically developing children, chosen to reflect the demographic variability of the Chicago area (Goldin-Meadow, Levine, Hedges, Huttenlocher, Raudenbush & Small, 2014). We took videotapes of each child at home with a primary caregiver for 90 minutes every 4 months between the ages of 1;2 and 4;10, and continued to observe the children through 10 years, giving them tests of language, reading, math, higher-order thinking, etc. (future observations are planned through age fifteen). These data have thus far been used to explore variability in children's talk early in development (e.g. Vasilyeva, Waterfall & Huttenlocher, 2008), and the relation between this early talk and later cognitive skills (Pruden, Levine & Huttenlocher, 2011; Levine, Suriyakham, Rowe, Huttenlocher & Gunderson, 2010).

Widening the lens on our observations

In addition to widening the profile of who we study, we have also widened what we study. Recent studies of language learning often focus not only on what children say with their mouths, but also on what they do with their hands, that is, on their gestures. Children use gestures even before they begin to use words (Bates, 1976), and gesture continues to be part of a child's communicative repertoire after the onset of speech, serving to extend the child's communicative range (e.g. a child says *gimme* while pointing at a cracker; gesture makes it clear what the object of *gimme* is).

But there is variability in gesture use across children, and it turns out that this variability can predict differences in the onset of linguistic milestones. For example, the range of different meanings children convey in gesture at 1;2 predicts the size of their spoken vocabulary at 4;6 (Rowe & Goldin-Meadow, 2009a). As another example, children vary in the age at which they produce combinations in which speech conveys one idea and gesture another (e.g. *nap* + point at bird) and this variability predicts the age at which children produce their first two-word utterance (*bird nap*; Goldin-Meadow & Butcher, 2003; Iverson & Goldin-Meadow, 2005). Once two-word speech has begun, the types of gesture+speech combination children produce continue to predict the onset of different types of multiword combinations (e.g. predicate+predicate: Özçaliskan & Goldin-Meadow, 2005; determiner+noun: Cartmill, Hunsicker & Goldin-Meadow, 2014).

Why does early gesture forecast later language? Early gesture might be an index of global communicative skill. For example, children who convey a large number of different meanings in their early gestures might be generally good language learners and/or have high levels of intelligence. If so, not only should these children have large vocabularies later in development, but their sentences ought to be relatively complex as well. The data do not support this hypothesis. Instead, we find that particular types of early gestures are specifically related to particular aspects of later spoken language use (Rowe & Goldin-Meadow, 2009b). More specifically, controlling for early vocabulary, number of different meanings conveyed in gesture early in development predicts the size of the comprehension vocabulary several years later, but number of gesture+speech combinations produced early in development does not; in contrast, controlling for early syntax, number of gesture+speech combinations produced early in development predicts syntactic complexity several years later, but number of different meanings conveyed in gesture early in development does not. The selectivity with which gesture predicts different linguistic skills suggests that the gestures are reflecting not just general intelligence or overall language learning ability, but rather skills specific to learning vocabulary or to learning syntax.

The fact that children express sentence-like ideas in a gesture+speech combination several months before they express these ideas in speech alone makes it clear that they have an understanding of these notions before they are able to express them in speech, thus eliminating one frequently held explanation for the slow acquisition of certain structures – the cognitive explanation, that is, that children do not express a given structure because they lack an understanding of the notion underlying the structure. Widening our lens to include gesture thus allows insight into when cognition does, and does not, shape the course of language learning.

In addition to serving as a window into the earliest steps a language learner takes, gesture has the potential to play a role in getting the learner to take those steps. For example, LeBarton, Raudenbush, and Goldin-Meadow (2014) have recently found that encouraging children aged 1;5 to gesture during a book-reading task not only increases the child's gesture rate, but also increases the size of the child's spoken vocabulary. Gesture can be part of the mechanism of change, another area in which advances have been made since 1974.

ADVANCES IN UNDERSTANDING HOW CHILDREN LEARN LANGUAGE

One way to explore the mechanisms that underlie language learning is to take advantage of variability across language learners and across language learning environments (Gleitman & Newport, 1996). To the extent that variability in either learner or learning environment results in differences in the way children learn a property of language, we have evidence that the factor (either internal or external to the learner) plays a role in learning that property. To the extent that variability in either learner or learning environment has no impact on the acquisition of a linguistic property, we have evidence that the development of this property is resilient, at least with respect to this factor.

Variations in language learners

Children who are deaf and born to deaf signing parents are exposed to a language system, but one that differs dramatically from the typical. It is language by hand and eye, rather than by mouth and ear. Does language learning take a different course when it is conducted in a different modality? The answer is that, for the most part, it does not – children learn language in the manual modality as easily and on the same timetable as children learning language in the oral modality (Newport & Meier, 1985). Similarly, children who are born blind and cannot take advantage of the visual input the world and their parents provide nevertheless acquire spoken language following the same trajectory as sighted children (Landau & Gleitman, 1985). Language learning is surprisingly resilient to variations in how linguistic input is taken in.

Another way to extend variation in language learners is to examine children who early in development suffer an insult to the brain. In general, children with unilateral brain injury to either hemisphere tend to acquire the early-appearing aspects of language on time or with minimal delays (e.g. Marchman, Miller & Bates, 1991). However, these children experience iterative difficulty with each aspect of language development as these skills come on line (Stiles, Reilly, Levine, Trauner & Nass, 2012), including complex syntactic (Levine, Huttenlocher, Banich & Duda, 1987) and narrative (e.g. Demir, Levine & Goldin-Meadow, 2010) skills. But there is considerable variation in the language learning skills of children with unilateral brain injury.

Although many studies have explored the relation between differences in language skill and biological characteristics (lesion laterality, location, and size; seizure history) in children with brain injury (e.g. Feldman, 2005), few studies have examined these differences in relation to linguistic input. Doing so has resulted in interesting findings. For example, Rowe, Levine, Fisher, and Goldin-Meadow (2009) analyzed vocabulary growth (word types) and syntactic growth (MLU) in children with brain injury, comparing these children to the typically developing children in the Chicago sample. They found, not surprisingly, that children with less input at 1;2 had lower vocabularies at 2;6 than children with more input, and that acceleration in growth was more profound for children with high than low input. The relation between parent speech and vocabulary did NOT differ based on brain injury status. However, MLU showed a different pattern – there was a bigger difference between rates of growth in MLU for high- and low-input children with brain injury than for high- and low-input typically developing children. Thus the effect that linguistic input has on children with brain injury, compared to typically developing children, can differ as a function of linguistic property.

In addition to looking at natural variation in language learners, we can also vary the learner experimentally by substituting adults as learners in a paradigm called 'human simulation' (Gleitman, 1990). If language learning is affected by the cognitive and social maturity of the learner, adults should go about learning in a very different way from children. To the extent that the trajectory is the same across child and adult learners, we have evidence that the to-be-learned information may be constraining the steps the learner takes, not the child's cognitive skills. Gillette, Gleitman, Gleitman, and Lederer (1999) explored this question with respect to noun and verb learning. Children have been found to learn nouns earlier than verbs (e.g., Gentner, 1982). Gillette *et al.* (1999) found that adults had more difficulty identifying verbs than nouns in mother-to-child talk, particularly when the words were presented without linguistic context. The findings suggest that the information requirements, rather than the conceptual requirements, of verb learning determine its late acquisition relative to noun learning.

Taking advantage of an unusual naturalistic situation to complement the human simulation approach, Snedeker, Geren, and Shafto (2007) examined the acquisition of nouns and verbs in internationally adopted preschoolers who were older, and thus more cognitively mature, than children are when they typically acquire their first nouns and verbs. They found that the adoptees initially learned a disproportionate number of nouns relative to verbs, thus supporting Gillette *et al.*'s (1999) view that verbs are not acquired later than nouns because of the child's conceptual limitations (see also Gleitman, Cassidy, Nappa, Papafragou & Trueswell, 2005).

Taken together, these findings suggest that the age of the learner has little impact on when verbs are learned in relation to nouns. However, age does have an impact on the acquisition of some properties of language. For example, Newport (1991) observed deaf individuals exposed to American Sign Language (ASL) for the first time at varying ages, and found that some properties of language (word order) were not affected by the learner's age, whereas other properties (morphological marking) varied systematically as a function of age – individuals exposed to ASL later in life had more difficulty mastering the morphological system of ASL than individuals exposed at birth or before age six. Some properties of language thus appear to be relatively resilient with respect to variations in the learner's state; others are relatively fragile.

Variations in language learning environments

Another way to explore the biases children bring to language learning is to observe learning in circumstances that vary in how much linguistic input children experience. The assumption is that children bring the same processing biases to whatever circumstances they encounter. To the extent that child outcomes remain the same across these various input situations, we have evidence that the child's processing biases are themselves important in determining the language the child develops – that the child's developmental trajectory is buffered from vagaries in the input. To the extent that each varying input situation results in a different child outcome, we not only have evidence that input matters, but we can begin to explore the patterns between input and child outcome to make inferences about the child's biases and processing strategies. For obvious ethical reasons, we cannot tamper with the circumstances under which children learn language. But we can take advantage of the varied circumstances that children find themselves in when attempting to learn language.

Taking advantage of typical variation in input. Children are not only exposed to different kinds of input across cultures, but they also experience variation in input within a culture – some parents talk often to their children and use a wide variety of constructions; others talk less. Does this variability affect child acquisition? Yes. Environmental effects have been found for both vocabulary (Huttenlocher, Haight, Bryk, Selzer & Lyons, 1991) and syntax

(Newport, Gleitman & Gleitman, 1977; Hoff-Ginsberg, 1986). For example, Huttenlocher, Waterfall, Vasilyeva, Vevea, and Hedges (2010) analyzed videotapes of the typically developing families in the Chicago sample during the period when complex syntax is beginning to be acquired (2;2–3;10). Rather than focus on total amount of parent and child speech, Huttenlocher *et al.*, analyzed diversity – the variety of words, phrases, and clauses produced by parents and children. They addressed the important question of 'who is influencing whom' by using lagged correlations (e.g. using parent speech at 2;2 to predict child speech at 2;6, parent speech at 2;6 to predict child speech at 2;10, etc.). Lagged correlations between parent speech at an earlier session and child speech at a later session (forward correlations) and between child speech at an earlier session and parent speech at a later session (backward correlations) allow a relatively fine-tuned assessment of directionality. For vocabulary, forward and backward correlations were both significant and equally large; that is, earlier parent speech predicted later child speech, and earlier child speech predicted later parent speech, suggesting a reciprocal relation between parent and child for vocabulary. In contrast, for syntax, forward correlations were significant but backward correlations (early child predicting later parent syntax) were not, suggesting an unequal relation between parent and child for syntax. The different patterns for vocabulary and syntax suggest that particular parent behaviors, rather than overall parent intelligence, are behind the correlations with child language learning.

The diversity measures used by Huttenlocher and colleagues (2010) are not independent of the quantity of talk parents address to their children. Cartmill, Armstrong, Gleitman, Goldin-Meadow, Medina, and Trueswell (2013) used the human simulation paradigm developed by Gillette *et al.* (1999) to assess quality of parent input to vocabulary development independent of quantity. They determined how easy it was to guess from non-linguistic context alone a randomly selected set of nouns produced by fifty of the parents in the Chicago sample. The more easily a word can be guessed, the more likely a child is to figure out, and then learn, the word – easily guessed words thus reflect high-quality word-learning experiences. They found that parents varied in the quality of word-learning experiences they gave their children at 1;2 and 1;6, and that this variability correlated with children's comprehension vocabulary three years later, controlling for quantity of parent input. Quantity and quality did not correlate with each other, and each accounted for different aspects of variance in child outcome. As has been repeatedly shown, quantity of parent input to word learning was positively related to socioeconomic status (SES). However, quality of parent input did NOT vary systematically with SES.

Extending variation in input by enriching or degrading it. As we have just seen, studies of natural variation in linguistic input can reveal positive effects of linguistic input on child output. For example, children who are early producers of auxiliaries tend to have mothers who, several months earlier, produced many auxiliaries at the beginning of their sentences (Newport *et al*., 1977). These positive effects, based on correlations, can be tested experimentally by manipulating the input children receive; in particular, by increasing the input children receive with respect to auxiliaries and showing selective effects of this input on child output (Nelson, 1977). Note, however, that if we find that a particular linguistic property is NOT sensitive to natural variations in linguistic input (e.g. the number of verbs per sentence; Newport *et al*., 1977), it could be because the property is truly not responsive to variations in input. But it could also be that all adults provide a sufficient amount of input necessary for this property to develop. It is only by degrading a child's input that we can amass positive evidence for the properties of language that are insensitive to linguistic input.

We cannot, of course, intentionally degrade children's linguistic input. There are, however, children who find themselves without access to usable linguistic input – deaf children with hearing losses so extensive that they cannot naturally acquire oral language, and born to hearing parents who have not exposed them to a conventional sign language. Under such inopportune circumstances, these deaf children might be expected to fail to communicate altogether. This turns out not to be the case. Despite their degraded language learning conditions, these children develop gestural communication systems, called HOMESIGNS, that contain many of the properties of natural language.

For example, homesigners' gestures form a lexicon. These lexical items are composed of parts, akin to a morphological system (Goldin-Meadow, Mylander & Franklin, 2007), and the lexical items combine to form structured sentences, akin to a syntactic system (Feldman, Goldin-Meadow & Gleitman, 1978). In addition, homesign contains lexical markers that modulate the meanings of sentences (negation and questions; Franklin, Giannakidou, & Goldin-Meadow, 2011), as well as grammatical categories (nouns and verbs; Goldin-Meadow, Butcher, Mylander & Dodge, 1994) and the hierarchical structure that comes from elaborating an argument in a sentence (using a determiner plus noun rather than a bare noun; Hunsicker & Goldin-Meadow, 2012) or adding a second proposition to a sentence (using a complex sentence; Goldin-Meadow, 1982). Moreover, homesign serves the typical functions that all languages serve, signed or spoken (Goldin-Meadow, 2003) – homesigns are used to make requests of others; to comment on the present and non-present; to make generic statements about classes of objects; to tell stories about real and imagined events; to talk to oneself; and to talk about language. The properties of language that crop up in homesign can be developed without input from a conventional language model and, in this sense, are resilient.

Here again, experimental approaches can be used to complement these studies of naturalistic variation. We can, for example, teach children (or adults, for that matter) artificial languages and observe how easily those languages are learned, or how the languages are altered in the learning. Properties of language that are easy to learn should be just the properties that homesigners are likely to invent, the resilient properties of language. Conversely, properties of language that are more difficult to learn should be the properties that are difficult for homesigners to invent, the fragile properties of language. There is, in fact, some evidence to support this hypothesis. For example, Fedzechkina, Jaeger, and Newport (2012) have recently found that, when adult learners are given an artificial language in which case marking is not conditioned on animacy, they change their input, increasing case marking on roles that violate the animacy hierarchy (i.e. they begin to mark inanimate agents and animate patients). Ongoing work on homesigning adults in Nicaragua is finding that verbs conveying events in which an animate agent acts on an animate patient (a violation of the animacy hierarchy) are more likely to be marked than verbs conveying events in which an animate agent acts on an inanimate patient (Flaherty, Goldin-Meadow, Senghas, Coppola & Gleitman, 2013).

RESILIENT AND FRAGILE PROPERTIES OF LANGUAGE

Any particular manipulation of the conditions under which language learning takes place has the potential to alter the language learning outcome. To the extent that a property of language is unaffected by a given manipulation, it can be said to be developmentally resilient – its developmental course is impervious to the change in conditions. Of course, the more radical the manipulation is – that is, the more different the conditions are from the conditions that surround the typical language learning situation – the more impressive it is that a given property of language continues to emerge. It is an empirical question as to whether the same property of language will survive a variety of manipulations – that is, whether it will be resilient across a range of learners and learning conditions. If so, we can be that much more certain that this particular property of language is fundamental to human communication, one whose development is not beholden to the vagaries of learners and learning conditions but is, instead, robustly overdetermined.

But we know that some properties of language will not survive a particular manipulation and may not survive a variety of manipulations. These are the fragile properties of language, properties whose development is sensitive to changes in input and learners. Although it is difficult to explore the conditions that foster the development of fragile properties of language, a new sign language emerging in Nicaragua offers an interesting perspective on this problem. Nicaraguan Sign Language (NSL) was born in the late

1970s and early 1980s when rapidly expanding programs in special education brought together in great numbers deaf children and adolescents who in all likelihood were, at the time, homesigners (Senghas, 1995). NSL has continued to develop as new waves of deaf children enter the community and learn to sign from older peers, and offers us the opportunity to explore three types of conditions that could have an impact on the structure of language.

First, we can explore the effect that increasing age has on the complexity of homesign. Some Nicaraguan homesigners do not come into contact with deaf signers even as adults and, as a result, continue to use their homesign systems with the hearing individuals in their worlds into adulthood. Analyses of adult homesign in Nicaragua have uncovered linguistic structures that go beyond the structures found thus far in child homesign (Coppola & Newport, 2005; Coppola & Senghas, 2010; Brentari, Coppola, Mazzoni & Goldin-Meadow, 2012; Coppola *et al.*, 2010). By contrasting the linguistic systems constructed by child and adult homesigners, we can see the impact that growing older has on language.

Second, we can explore the effect that sharing a communication system within a group has on the complexity of language. Before coming together, the first cohort of NSL interacted only with hearing individuals who did not share their homesign systems (e.g. Coppola *et al.*, 2013). Having a group with whom they could communicate meant that the first cohort of signers were not only producers of their linguistic system but also receivers of the system, a circumstance that could lead to a system with greater systematicity – but perhaps less complexity, as the group may need to adjust to the lowest common denominator.

Third, we can explore the effect that transmitting a communication system to a new generation has on complexity. The second cohort of NSL had the first cohort as their linguistic input. Having a system with an established lexicon and structural regularities to serve as a base allowed the second (and subsequent) cohorts to further develop their communication system (e.g. Senghas, 2003). Once learners are exposed to a system that has linguistic structure (i.e. cohort 2 and beyond), the processes of language change may be identical to the processes studied in historical linguistics. One interesting question is whether the changes seen in NSL in its earliest stages are of the same type and magnitude as the changes that occur in mature languages over historical time.

Overall, the unique situation in Nicaragua allows us to determine which properties of language are not resilient, and to explore several conditions that have the potential to support the appearance of these relatively fragile properties in communication.

There is no doubt that the linguistic system a child develops is shaped by characteristics of the input the child receives, as elegant studies of statistical learning have shown us (e.g. Saffran, Aslin & Newport, 1996). But the fact that children are excellent statistical learners does not explain how homesigners can incorporate structures into their gestures that resemble natural language (but do not resemble the co-speech gestures their hearing parents use with them; Goldin-Meadow & Mylander, 1983, 1998). Nor does it explain why learners sometimes change the input to which they are exposed (input from either a natural or an artificial language). Children are prepared to learn language. Our task now, as it was in 1974, is to figure out what they are prepared with. The new tools and paradigms that have been introduced into the field since 1974 offer great promise for accomplishing this task.

REFERENCES

Bates, E. (1976). *Language and context: the acquisition of pragmatics*. New York: Academic Press.

Brentari, D., Coppola, M., Mazzoni, L. & Goldin-Meadow, S. (2012). When does a system become phonological? Handshape production in gesturers, signers, and homesigners. *Natural Language and Linguistic Theory* **30**(1), 1–31.

Cartmill, E. A., Armstrong, B., Gleitman, L., Goldin-Meadow, S., Medina, T. & Trueswell, J. (2013). Quality of early parent input predicts child vocabulary three years later. *Proceedings of the National Academy of Sciences* **110**(28), 11278–83.

Cartmill, E. A., Hunsicker, D. & Goldin-Meadow, S. (2014). Pointing and naming are not redundant: children use gesture to modify nouns before they modify nouns in speech. *Developmental Psychology*, in press.

Coppola, M. & Newport, E. (2005) Grammatical subjects in homesign: abstract linguistic structure in adult primary gesture systems without linguistic input. *Proceedings of the National Academy of Sciences* **102**(52), 19249–53.

Coppola, M. & Senghas, A. (2010). The emergence of deixis in Nicaraguan signing. In D. Brentari (ed.), *Sign languages: a Cambridge language survey*, 543–69. Cambridge: Cambridge University Press.

Coppola, M., Spaepen, E. & Goldin-Meadow, S. (2013). Communicating about quantity without a language model: number devices in homesign grammar. *Cognitive Psychology* **67**, 1–25.

Demir, O. E., Levine, S. C. & Goldin-Meadow, S. (2010). Narrative skill in children with early unilateral brain injury: a possible limit to functional plasticity. *Developmental Science* **13**(4), 636–47.

Fedzechkina, M., Jaeger, T. F. & Newport, E. L. (2012). Language learners restructure their input to facilitate efficient communication. *Proceedings of the National Academy of Sciences* **109**, 17897–902.

Feldman, H. M. (2005). Language learning with an injured brain. *Language Learning and Development* **1**(3/4), 265–88.

Feldman, H. M., Goldin-Meadow, S. & Gleitman, L. (1978). Beyond Herodotus: the creation of language by linguistically deprived deaf children. In A. Lock (ed.), *Action, symbol, and gesture: the emergence of language*, 351–414. New York: Academic Press.

Flaherty, M., Goldin-Meadow, S., Senghas, A., Coppola, M. & Gleitman, L. (2013). Animacy and verb classes in Nicaraguan Sign Language. Poster presented at the 38th meeting of the Boston University Conference on Language Development, Boston, MA.

Franklin, A., Giannakidou, A. & Goldin-Meadow, S. (2011). Negation, questions, and structure building in a homesign system. *Cognition* **118**(3), 398–416.

Gentner, D. (1982). Why nouns are learned before verbs: linguistic relativity versus natural partitioning. In S. A. Kuczaj (ed.), *Language development: syntax and semantics*. Hillsdale, NJ: Erlbaum.

Gillette, J., Gleitman, H., Gleitman, L. & Lederer, A. (1999). Human simulations of vocabulary learning. *Cognition* **73**(2), 135–76.

Gleitman, L. R. (1990). The structural sources of word meaning. *Language Acquisition* **1**(1), 3–55.

Gleitman, L. R., Cassidy, K., Nappa, R., Papafragou, A. & Trueswell, J. C. (2005). Hard words. *Language Learning and Development* **1**(1), 23–64.

Gleitman, L. & Newport, E. (1996). The invention of language by children: environmental and biological influences on the acquisition of language. In L. Gleitman & M. Liberman (eds), *An invitation to cognitive science, 2nd ed., Vol. 1: language*, 1–24. Cambridge, MA: MIT Press.

Goldin-Meadow, S. (1982). The resilience of recursion: a study of a communication system developed without a conventional language model. In E. Wanner & L. R. Gleitman (eds), *Language acquisition: the state of the art*, 51–77. New York: Cambridge University Press.

Goldin-Meadow, S. (2003). *The resilience of language*. New York: Psychology Press.

Goldin-Meadow, S. & Butcher, C. (2003). Pointing toward two-word speech in young children. In S. Kita (ed.), *Pointing: where language, culture, and cognition meet*. Hillsdale, NJ: Erlbaum.

Goldin-Meadow, S., Butcher, C., Mylander, C. & Dodge, M. (1994). Nouns and verbs in a self-styled gesture system: What's in a name? *Cognitive Psychology* **27**, 259–319.

Goldin-Meadow, S., Levine, S. C., Hedges, L. V., Huttenlocher, J., Raudenbush, S. & Small, S. (2014). New evidence about language and cognitive development based on a longitudinal study: hypotheses for intervention. *American Psychologist* in press.

Goldin-Meadow, S. & Mylander, C. (1983). Gestural communication in deaf children: the non-effects of parental input on language development. *Science* **221**, 372–4.

Goldin-Meadow, S. & Mylander, C. (1998). Spontaneous sign systems created by deaf children in two cultures. *Nature* **91**, 279–81.

Goldin-Meadow, S., Mylander, C. & Franklin, A. (2007). How children make language out of gesture: morphological structure in gesture systems developed by American and Chinese deaf children. *Cognitive Psychology* **55**, 87–135.

Hart, B. & Risley, T. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Brookes Publishing.

Hoff-Ginsberg, E. (1986). Function and structure in maternal speech: their relation to the child's development of syntax. *Developmental Psychology* **22**, 155–63.

Hunsicker, D. & Goldin-Meadow, S. (2012). Hierarchical structure in a self-created communication system: building nominal constituents in homesign. *Language* **88**(4), 732–63.

Huttenlocher, J., Haight, W., Bryk, A., Selzer, M. & Lyons, T. (1991). Early vocabulary growth: relation to language input and gender. *Developmental Psychology* **27**, 236–48.

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J. & Hedges, L. (2010). Sources of variability in children's language growth. *Cognitive Psychology* **61**, 343–65.

Iverson, J. M. & Goldin-Meadow, S. (2005). Gesture paves the way for language development. *Psychological Science* **16**, 368–71.

Landau, B. & Gleitman, L. R. (1985). *Language and experience: evidence from the blind child*. Cambridge, MA: Harvard University Press.

LeBarton, E. S., Raudenbush, S. & Goldin-Meadow, S. (2014). Experimentally-induced increases in early gesture lead to increases in spoken vocabulary. *Journal of Cognition and Development* in press.

Levine, S. C., Huttenlocher, P., Banich, M. & Duda, E. (1987). Factors affecting cognitive functioning of hemiplegic children. *Developmental Medicine and Child Neurology* **29**, 27–35.

Levine, S. C., Suriyakham, L. W., Rowe, M. L., Huttenlocher, S. & Gunderson, E. A. (2010). What counts in the development of young children's number knowledge? *Developmental Psychology* **46**, 1309–19.

MacWhinney, B. (1977). Starting points. *Language* **53**, 152–68.

MacWhinney, B. (1995). *The CHILDES project: tools for analyzing talk*, 2nd ed. Hillsdale, NJ: Erlbaum.

Marchman, V. A., Miller, R. & Bates, E. (1991). Babble and first words in children with focal brain injury. *Applied Psycholinguistics* **12**, 1–22.

Nelson, K. E. (1977). Facilitating children's syntax acquisition. *Developmental Psychology* **13**, 101–7.

Newport, E. L. (1991). Contrasting conceptions of the critical period for language. In S. Carey & R. Gelman (eds), *The epigenesis of mind: essays on biology and cognition*, 11–130. Hillsdale, NJ: Earlbaum.

Newport, E. L., Gleitman, H. & Gletiman, L. R. (1977). Mother, I'd rather do it myself: some effects and noneffects of maternal speech style. In C. E. Snow & C. A. Ferguson (eds), *Talking to children: language input and acquisition*, 109–50. Cambridge: Cambridge University Press.

Newport, E. L. & Meier, R. P. (1985). The acquisition of American Sign Language. In D. I. Slobin (ed.), *The cross-linguistic study of language acquisition, Vol. 1: the data*, 881–938. Hillsdale, NJ: Erlbaum.

Özçalişkan, S. & Goldin-Meadow, S. (2005). Gesture is at the cutting edge of early language development. *Cognition* **96**, B01–113.

Pan, B. A., Rowe, M. L., Singer, J. D. & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development* **76**(4), 763–82.

Pruden, S. M., Levine, S. C. & Huttenlocher, J. (2011). Children's spatial thinking: Does talk about the spatial world matter? *Developmental Science* **14**, 1417–30.

Rowe, M. L. & Goldin-Meadow, S. (2009a). Differences in early gesture explain SES disparities in child vocabulary size at school entry. *Science* **323**, 951–3.

Rowe, M. L. & Goldin-Meadow, S. (2009b). Early gesture selectively predicts later language learning. *Developmental Science* **12**(1), 182–7.

Rowe, M. L., Levine, S. C., Fisher, J. & Goldin-Meadow, S. (2009). The joint effects of biology and input on the language development of brain-injured children. *Developmental Psychology* **45**, 90–102.

Saffran, J. R., Aslin, R. N. & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science* **274**, 1926–8.

Schieffelin, B. B. (1985). The acquisition of Kaluli. In D. I. Slobin (ed.), *The cross-linguistic study of language acquisition, Vol. 1: the data.*, 525–93. Hillsdale, NJ: Erlbaum.

Senghas, A. (1995). *Children's contribution to the birth of Nicaraguan Sign Language*. (Unpublished PhD dissertation) Massachusetts Institute of Technology, Cambridge, MA.

Senghas, A. (2003). Intergenerational influence and ontogenetic development in the emergence of spatial grammar in Nicaraguan Sign Language. *Cognitive Development* **18**(4), 511–31.

Slobin, D. I. (1966). The acquisition of Russian as a native language. In F. Smith & C. Miller (eds), *The genesis of language: a psycholinguistic approach*, 129–52. Cambridge, MA: MIT Press.

Slobin, D. I. (1985). Introduction: Why study acquisition crosslinguistically? In D. I. Slobin (ed.), *The cross-linguistic study of language acquisition, Vol. 1: the data.*, 3–24. Hillsdale, NJ: Erlbaum.

Slobin, D. I. (1992). The crosslinguistic endeavor. In D. I. Slobin (ed.), *A cross-linguistic study of language acquisition, Volume 3*, 1–13. Hillsdale, NJ: Erlbaum.

Snedeker, J., Geren, J. & Shafto, C. L. (2007). Starting over: international adoption as a natural experiment in language development. *Psychological Science* **18**(1), 79–87.

Stiles, J., Reilly, J. S., Levine, S. C., Trauner, D. & Nass, R. D. (2012). *Neural plasticity and cognitive development: insights from children with perinatal brain injury*. Oxford University Press.

Vasilyeva, M., Waterfall, H. & Huttenlocher, J. (2008). Emergence of syntax: commonalities and differences across children. *Developmental Science* **11**, 84–97.