CHILD DEVELOPMENT PERSPECTIVES

Discovering the Biases Children Bring to Language Learning

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ABSTRACT—***The linguistic input children receive has a massive and immediate effect on their language acquisition. This fact makes it difficult to discover the biases that children bring to language learning simply because their input is likely to obscure those biases. In this article, I turn to children who lack linguistic input to aid in this discovery: deaf children whose hearing losses prevent their acquisition of spoken language and whose hearing parents have not yet exposed them to sign language. These children lack input from a conventional language model, yet create gestures, called* homesigns*, to communicate with hearing individuals. Homesigns have many, although not all, of the properties of human language. These properties offer the clearest window onto the linguistic structures that children seek as they either learn or, in the case of homesigners, construct language.***

KEYWORDS—*homesign; linguistic input; cospeech gesture; morphology; syntax; hierarchical structure*

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Students of language acquisition agree on one noncontroversial point: Children learn the language to which they are exposed. They also agree, although less universally, that at some point in the acquisition process, children learn how linguistic properties, such as nouns, verbs, subjects, and hierarchy, are instantiated in the language they are learning. There the agreement stops.

Some researchers focus on the fact that children quickly generalize from the impoverished linguistic input they receive (Chomsky, 1980), and argue that they do so because they come to language learning with inborn linguistic knowledge (e.g., Gleitman & Newport, 1995; Gordon, 1985; Lidz, Waxman, & Freedman, 2003; Valian, 2014). Other researchers focus on the fact that children closely track the particular linguistic input to which they are exposed (e.g., Behrens, 2009; Goldberg, 2016; Lieven, 2016), and argue that children need time to generalize from the data they receive and thus likely construct linguistic properties without inborn knowledge of those properties (Tomasello, 2005, 2009).

It has proven difficult to assess how quickly children generalize and thus make the leap from language data to linguistic properties. Meylan, Frank, Roy, and Levy (2017) developed a Bayesian statistical model to measure degree of abstraction as English-learning children acquire the determiner–noun construction – in English, determiners ("a," "the") combine productively with nouns to create noun phrases (e.g., "a dog," "the dog," "a book," "the book"). They found low levels of productivity in the construction at the outset, followed by higher levels shortly thereafter, thus pinpointing the moment when children make the appropriate generalization about determiners and nouns in English. However, these findings cannot tell us whether children have some idea of the generalization they are about to make *prior* to the moment of insight – a child might well have rich grammatical understanding of the construction at the outset and lack only an understanding of how that knowledge is instantiated in English.

Data from children who are developing a communication system in the absence of linguistic input help with this problem. If a child who lacks linguistic input develops a particular property

of language, the motivation for that property must come from the child, not a conventional language model. Thus, the properties developed by children in this situation are good candidates for the types of rich grammatical knowledge that all children bring to language learning.

Of course, children are rarely in a situation in which they lack linguistic input. One exception is deaf children whose hearing losses have prevented them from acquiring the spoken language that surrounds them and whose hearing parents have not exposed them to sign language. A child in these circumstances lacks usable input from a conventional language. Nevertheless, the child can develop a system of gestures – called *homesigns* – that contain many, although not all, of the properties of natural language (Goldin-Meadow, 2003a). Homesigners do not develop their gestures in a vacuum; they are surrounded by hearing family members who attempt to communicate with them using speech (which the homesigners cannot hear) and cospeech gesture. Although cospeech gesture may give homesigners the impetus to communicate, it does *not* offer a model for the linguistic properties found in homesign and described in the next sections. Nor do the responses that hearing parents make to homesigners' gestures shape the structure of those gestures (Goldin-Meadow & Mylander, 1984).

Consequently, homesign can help identify the so-called resilient properties of language (Goldin-Meadow, 2003a)—linguistic properties children can develop without input from a conventional language model. These properties provide empirical data that address the question of which biases children bring to language learning. In this article, I focus on a small set of linguistic properties that have not been the focus of a single review to illustrate the kinds of biases children may bring to communication. These biases direct language creation if a child does *not* receive a language model, and may guide language acquisition if a child *does* receive a model for a particular language. The supplementary materials (available online) include a list of all resilient properties identified in homesign thus far, along with citations for each property and the number, nationality, and age (child/adult) of participants in each study. I conclude the article with directions for research.

A WORD ABOUT METHODS

My colleagues and I have observed homesigners across many studies in several cultures: the United States, China, Turkey, and Nicaragua. Recruiting homesigners is labor intensive, making it difficult to gather large samples. In the United States, China, and Turkey, children have been recruited through oral schools for the deaf. In Nicaragua, children and adults were recruited through contacts in the deaf community; children were also recruited through the school for the deaf in Managua just before they learned Nicaraguan Sign Language from their deaf peers. All children and adults were profoundly deaf and unable to learn spoken language even with hearing aids (which only some wore), and none had received cochlear implants. Moreover, none had been exposed to an established sign language. But all developed gestural systems to communicate with their hearing family members and thus were considered homesigners.[1]

We observed the children in their homes as they interacted with their hearing families, using procedures described previously (Goldin-Meadow & Mylander, 1984). During the observation sessions, the children played with toys and communicated spontaneously about picture books, and about events and objects in their environments. Hearing family members communicated freely with the homesigners with minimal interference from experimenters. Sessions were videotaped for later coding and analysis (see Goldin-Meadow, 2003a, for details). Adults were shown vignettes of carefully chosen scenes and asked to describe them (e.g., Gleitman, Senghas, Flaherty, Coppola, & Goldin-Meadow, 2019; Goldin-Meadow, Brentari, Coppola, Horton, & Senghas, 2015).

SEGMENTS, NOT UNANALYZED WHOLES: WORDS

One of the more striking aspects of the homesigns produced by all the deaf children and adults we have observed is that the gestures are narrowly referential, even though the manual modality is conducive to painting scenes in the air that could portray an event in its entirety. For example, to indicate that she just ate a bowl of soup, a homesigner could re-enact the scene as a mime would. But homesigners do not communicate in this way. Rather, they segment out components of an event and portray each component with a separate gesture. Figure 1, at the top, presents a U.S. homesigner offering the experimenter a snack: First, he jabs his hand at his mouth (an iconic gesture for *eat*), and then he points with his palm toward the experimenter (a deictic gesture for *you*). In Figure 1, at the bottom, the child again offers the experimenter the snack but happens to be holding a toy hammer; he points at the snack with the hammer, gestures *eat* while holding the hammer, and then points the hammer at the experimenter. In addition to creating a separate gesture for each component of the event (i.e., separate gestures for the snack, the eating act, and the experimenter), the child uses movements that are abstractions of actions performed in the real world and are consequently not fully depictive forms.

Another example of homesigners eschewing veridical depiction comes from verb forms used to express symmetrical versus reciprocal relations (Gleitman et al., 2019). For example, consider the symmetrical relation of high-fiving, performed by two people doing the same movements at the same time to form a

[1]In my studies, I have encountered only one deaf child of hearing parents who did not rely primarily on gesture to communicate, and this child acquired spoken English easily. However, deaf children who come to language learning with organic difficulties or who experience difficult environmental circumstances might not use gesture spontaneously to communicate.

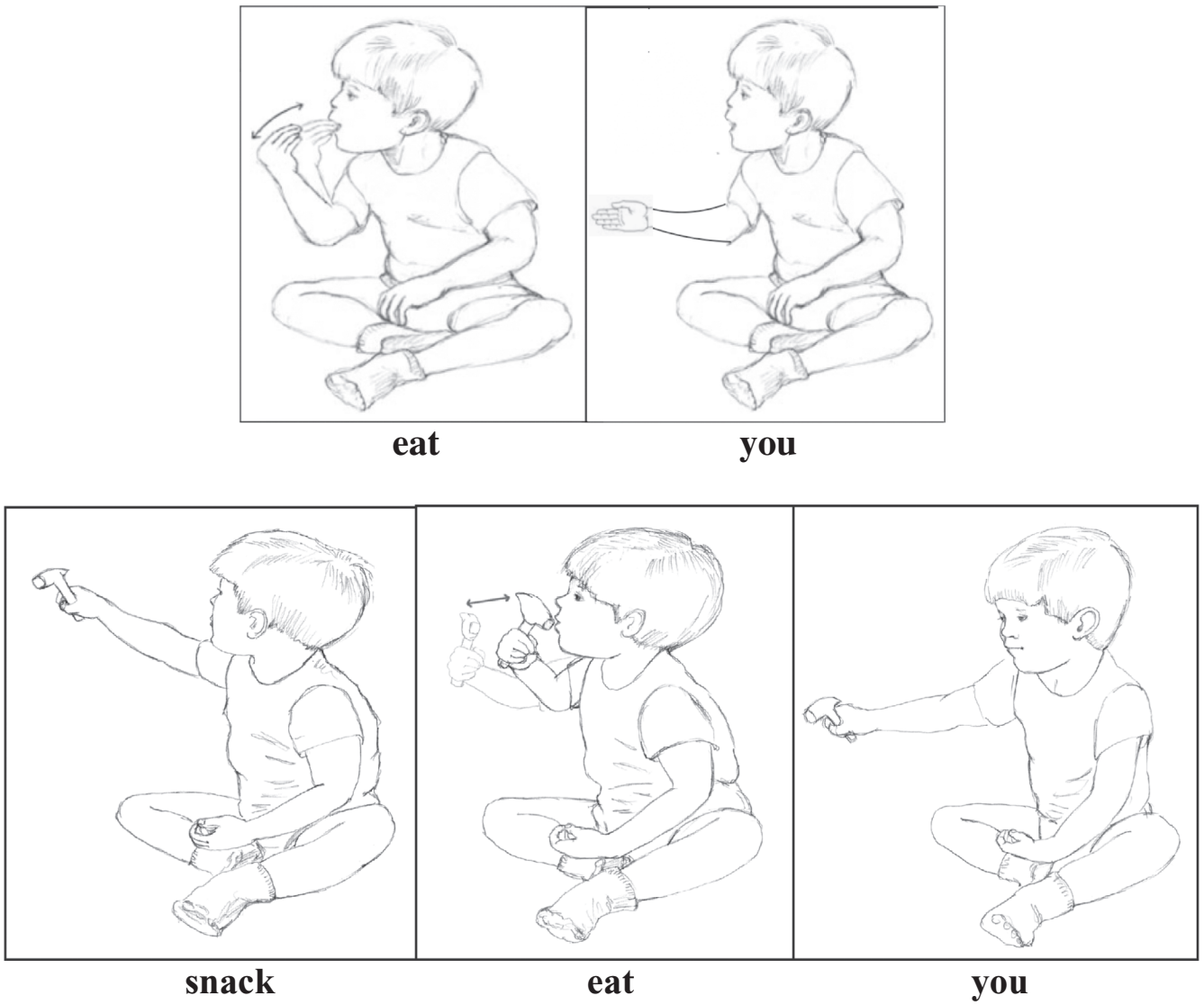

Figure 1. Examples of a homesigner stringing together discrete lexical symbols into gesture sentences characterized by consistent order. Top: A homesigner produces an iconic gesture for eat, followed by a deictic point at the experimenter, to invite the experimenter to join him in a snack. Bottom: The same homesigner repeats the offer but this time holding a toy hammer – he points at the snack with the hammer, produces the eat gesture with the hammer, and then points at the experimenter with the hammer – thus, illustrating how far from mime homesign can be. Adapted from drawings in Goldin-Meadow, 2003a.

single act. In English, such an event would be described as "John and Mary high-fived." Not surprisingly, when adult homesigners in Nicaragua construct verbs to portray symmetrical relations like high-fiving, they use mirrored forms in which the right and left hands perform the same movements and meet in the middle near the chest. The surprise is in the forms the homesigners use to express reciprocal relations, such as two people simultaneously punching each other. Even if the punching acts look symmetrical (John punches Mary at the same time, and in the same way, as Mary punches John), homesigners do not use mirrored forms to express the punching acts. Instead, they produce a nonmirrored punch (using only one hand or two asymmetrical hands), often followed by a second nonmirrored punch. In this way, homesigners avoid using a mimetic form that would have been a more veridical portrayal of the punching event in favor of a form that distinguishes reciprocal from symmetrical relations. This distinction is marked in English by the fact that we cannot describe a reciprocal relation using the symmetrical form; that is, we cannot say, "John and Mary punched" – we must say "John and Mary punched *each other*." Homesigners make this distinction, too: They use a nonmirrored form for reciprocals that does *not* capture the visible symmetry of the two simultaneous punching events.

SEGMENTS DIVIDED INTO SUBPARTS: MORPHEMES

The segmented gestures that form the words of homesign can themselves be divided into parts, akin to morphemes that

combine to create larger units whose meanings are a composite of the meanings of the parts (Goldin-Meadow, Mylander, & Butcher, 1995; Goldin-Meadow, Mylander, & Franklin, 2007). All the U.S. and Chinese child homesigners whose gestures we have examined for morphological structure produced gestures composed of a limited set of handshape forms, each standing for a class of objects, and a limited set of motion forms, each standing for a class of actions. These handshape and motion components combine to create words, and the meanings of these words are predictable from the meanings of their component parts. For example, an *OTouch* handshape form (a hand shaped like an "O" with the fingers touching the thumb), combined with a *Revolve* motion form, means "rotate an object < 2 inches wide around an axis," a meaning that can be transparently derived from the meanings of its two parts (*OTouch* = handle an object < 2 inches wide + *Revolve* = rotate around an axis). In terms of arguing that homesign is characterized by a morphological *system*, most gestures that each homesigner produces conform to the morphological description for that homesigner, and the descriptions can be used to predict new gestures the homesigner produces (see also Rissman & Goldin-Meadow, 2017, for evidence of causation-encoding morphology in homesign).

Nicaraguan homesigners also systematically incorporate number marking into iconic gestures serving a predicate role (e.g., producing a *grow* gesture with three fingers extended to describe three flowers growing out of a single box; Coppola, Spaepen, & Goldin-Meadow, 2013), as well as deictic gestures serving a nominal role (e.g., pointing at a set of objects with three fingers extended to indicate that the set contains three objects; Abner, Namboodiripad, Spaepen, & Goldin-Meadow, 2020). Thus, number is expressed productively on both predicates and nominals, providing evidence for a paradigmatic morphological system where words are analyzable into discrete meaningful units.

SEGMENTS COMBINED INTO STRUCTURED STRINGS: SENTENCES

Given that all homesigners produce gestures that look like beads on a string, the next question is whether (and how) that string is organized. The beads could be produced in random order, but they turn out not to be. Homesigners in the United States (Goldin-Meadow & Feldman, 1977), China (Goldin-Meadow & Mylander, 1998), Turkey (Goldin-Meadow, Namboodiripad, Mylander, Ozyurek, & Sancar, 2015), and Nicaragua (Flaherty, 2014) tend to produce gestures following consistent orders based on the thematic roles the gestures represent. For example, in Figure 1, at the top, a U.S. homesigner produces a gesture for the act (*eat*), the *V*erb, before a gesture for the doer (*you*), the *S*ubject – a *VS* order. In Figure 1, at the bottom, he adds a gesture for the done-to (*snack*), the *O*bject, but adheres to the same framing order – *OVS*. This homesigner uses *OVS* for most of the gesture sentences he produces that contain these three elements (Goldin-Meadow, Yalabik, & Gershkoff-Stowe, 2000), although he (like all homesigners) often omits gestures for agents (i.e., Subjects) and thus produces primarily *OV* sentences (Goldin-Meadow & Mylander, 1984).

The fact that all homesigners use word order to organize their sentences and mark who is doing what to whom suggests that *consistent word order* is a resilient property of language. Word order turns out to be robust under other unusual language-learning situations. For example, when deaf individuals are exposed to conventional language late in life, they seem unable to learn certain aspects of language, but word order is intact no matter at what age the individual is first exposed to language (Cheng & Mayberry, 2019; Newport, 1990). Thus, consistent order based on the thematic roles that the words in the sentence represent is a bias that children bring to communication.

When learning languages, this bias is ordering thematic roles *per se*, not the particular ordering of the roles. However, homesigners around the globe seem to have settled on many of the same orders, even though they do not know one another. For example, United States (Goldin-Meadow & Mylander, 1984), Chinese (Goldin-Meadow & Mylander, 1998), and Turkish (Goldin-Meadow, 2015) child homesigners all use *OV* order. Moreover, if hearing speakers of a variety of languages are asked not to talk but to use their hands (i.e., to use *silent* gesture) to describe events involving an animate person acting on an inanimate object, they all use *SOV* gesture order (Gibson et al., 2013; Goldin-Meadow, So, Ozyurek, & Mylander, 2008; Hall, Ferreira, & Mayberry, 2014; Hall, Mayberry, & Ferreira, 2013; Ozcaliskan, Lucero, & Goldin-Meadow, 2016). Although *OV* order may be cognitively basic (or perhaps natural to the manual modality), recall that the child in Figure 1 places the *S* after the *OV* unit, not before it. Taken together, these findings reinforce the point that the bias children bring to language learning is *not* to use a particular order in their communications, it is to use order *per se*.

SEGMENTS ORGANIZED HIERARCHICALLY: CONSTITUENT STRUCTURE

All languages, signed or spoken, are organized hierarchically, with structure at phonological, morphological, syntactic, and discourse levels. Homesign also has hierarchical structure. All homesigners use pointing gestures (e.g., point at a penny = *that*) and iconic gestures (e.g., thumb and finger forming a small round circle = *penny*) to refer to objects. At times, U.S. and Nicaraguan child homesigners use both gestures in a single sentence to refer to the same object (Flaherty, Hunsicker, & Goldin-Meadow, 2020). Figure 2 shows a U.S. homesigner producing an iconic gesture for *penny*, pointing at the penny, and pointing at himself to request that the experimenter give him a penny (*penny that me*).The pointing gesture indicates the particular penny the child wants and the iconic gesture provides information about its class. These types of multigesture nominals, akin to a determiner–noun construction (e.g., *penny that*),

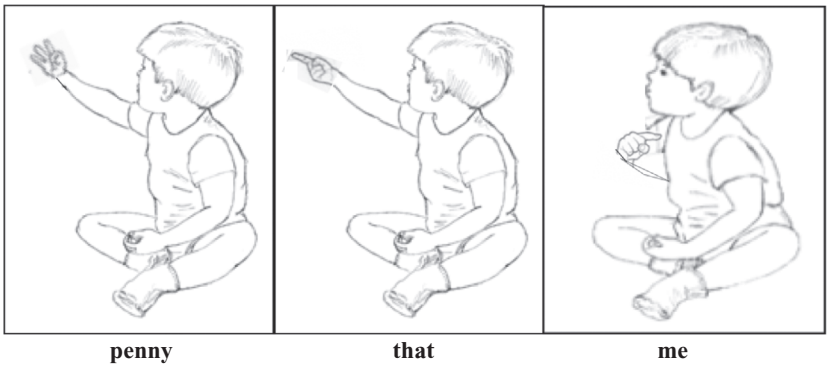

Figure 2. Example of a homesigner producing a gesture sentence containing a complex noun phrase and thus characterized by hierarchical structure. The homesigner produces an iconic gesture for *penny*, followed by a point at the penny, followed by a point at his own chest, to ask the experimenter to give him a particular penny ((*penny that*) *me*. Adapted from drawings in Goldin-Meadow, 2003a.

function semantically and syntactically like nominals containing only one gesture (Hunsicker & Goldin-Meadow, 2012). This finding suggests that the two gestures referring to the penny are embedded within a larger unit – ((*penny that*) *me*) – thus creating hierarchical structure.

Determiner–noun constructions in homesign display productive combinatorial structure not only when analyzed using the traditional techniques that reveal productivity in young hearing children's spoken language (cf. Goldin-Meadow & Mylander, 1984) but also when analyzed using a new formal analysis developed to assess productivity in young English-learning children's determiner–noun constructions (Yang, 2013). Applying this formal analysis to a U.S. child's homesign, Charles Yang and I found that all the linguistic constructions examined – including determiner–noun combinations – met the criterion for productivity (Goldin-Meadow & Yang, 2017). This finding provides powerful evidence that a child can create a combinatorial linguistic system without linguistic input, suggesting that children come to language learning with rich grammatical knowledge of at least some linguistic properties.

Returning to the debate with which we began, we see that children *do* come to language learning with biases and that those biases can be found in homesign. However, there are at least two caveats. First, just because a property of language appears in homesign does not mean that the bias to develop this property plays a role in how children learn language from a model. The biases that guide homesigners' *creation* of language might not be engaged when children *learn* language from another. Researchers can begin to examine this issue (which I discuss in the next section). Second, the absence of a property of language in homesign cannot be considered definitive evidence that children do *not* have a bias to develop the property. Homesign is only one window onto the biases children bring to language learning; other biases may not have been found yet, or perhaps cannot be found, in homesign. However, the absence of a property of language in homesign does suggest that the conditions under which homesign emerges are not sufficient for this property to develop. We can then search for conditions that lead to the development of the property. For example, devices for backgrounding agents (i.e., devices that allow agents to be downplayed in favor of other roles; e.g., "The door was closed by Charlie" as opposed to "Charlie closed the door") are not found in homesign (even adult homesign). But these devices emerge when young deaf children are exposed to homesign systems, suggesting that transmitting the language to new learners may be essential for this property to emerge (Rissman et al., 2020).

RESEARCH QUESTIONS AND CONCLUSIONS

Child homesigners, by definition, do not receive input from an established language, yet are as ready to learn language as any other child. But the only usable input they receive are the cospeech gestures their hearing parents use with them, which (as noted earlier) do not display linguistic structure (Goldin-Meadow, 2003b). Cospeech gesture is not characterized by discrete word-like components, but instead displays an analogical and mimetic relation to the elements it reflects (McNeill, 1992). Nor does it routinely display morphological (Goldin-Meadow et al., 1995, 2007), sentential (Goldin-Meadow & Mylander, 1983), or hierarchical (Flaherty et al., 2020; Hunsicker & Goldin-Meadow, 2012) structure.

If homesigners are using their hearing parents' gestures as input, they must be taking those gestures and turning them into linguistic form. Thus, homesign offers a window onto the internal processes children apply to whatever input they receive to arrive at linguistic structure. However, homesign data do *not* tell us whether these internal processes are specific to language learning or recruited across a range of cognitive domains. We need to examine processes in a *nonlinguistic* context to address this domain specificity question. For example, in one study, adult speakers of English, Chinese, Spanish, and Turkish were asked to use transparent pictures to reconstruct a scene in which an animate person acts on an inanimate object; they did not have

to pick up the pictures in a particular order and order was not mentioned. Nevertheless, all participants picked up the pictures following the same consistent order (*doer*, *done-to*, *act*), despite differences in the canonical orders of the languages they spoke (Goldin-Meadow et al., 2008; see also Gershkoff-Stowe & Goldin-Meadow, 2002). The order in which participants picked up the pictures was reminiscent of the *SOV* order seen in silent gesture, suggesting that imposing an order onto elements of an action is *not* specific to language. Researchers can explore other processes identified through homesign in nonlinguistic contexts.

Children's internal processes are often masked in typical language-learning environments because linguistic structure is present in their input and need not be imposed by the child. Nevertheless, we might get a glimpse of these processes in the speed with which children exposed to language models acquire particular linguistic structures. For example, structures found in homesign may be acquired earlier, or with less input, than structures absent from homesign. Researchers can test hypotheses generated from homesign on language-learning data in typical environments.

The structures that homesigners introduce into their gestures can also be used as a basis for the biases that need to be built into language-learning models. Incorporating biases culled from homesign into these models may allow the models to learn language, not necessarily as efficiently as possible, but as a human child would. Models that do and do not incorporate language-learning biases culled from homesign can then be tested against longitudinal data of parent input and child output in typical language-learning environments (e.g., data described in Goldin-Meadow et al., 2014). Models equipped with biases gleaned from homesign, when applied to a particular parent's input, may generate an output that fits the developmental pattern in the child of that parent better than models without biases. If so, we will have not only a reasonable model for how children learn language but also evidence for the biases that need to be built into human language learners. In addition, we will have evidence that the properties homesigners create provide insight into how all children learn language.

Finally, language acquisition takes place over ontogenetic time – children are typically exposed to a language by their parents and acquire that language during childhood. In contrast, language emergence takes place over historical time – describing how language is created and evolves in the absence of prior language. Although language emergence must have occurred in the oral modality at some point, it is difficult to study in the oral modality; however, language emergence can be studied in the manual modality (Brentari & Goldin-Meadow, 2017). Homesigners like those described here first came into contact with each other in Nicaragua 40 years ago, and established a communication system that led to the emergence of a new sign language, Nicaraguan Sign Language (Senghas, 2003). Thus, findings from homesign shed light on the foundations of this newly emerging language. The next question to explore is how homesign changes as it is shared with other users and transmitted to subsequent generations (e.g., Rissman et al., 2020).

In summary, homesign points to the properties of language that are central to human language – properties that do not need to be handed down from generation to generation, but can be invented anew by each subsequent generation. These properties are good candidates for the types of rich grammatical knowledge that all children bring to language learning. Consequently, homesign offers one of the clearest windows onto the linguistic structures that children seek as they either learn or, in the case of homesigners, construct language.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Table S1. The resilient properties of language.