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Creating and Learning Language by Hand

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▶ ***Please tell us about your current position and research interests.***
I am the Beardsley Ruml Distinguished Service Professor in the Departments of Psychology and Comparative Human Development at the University of Chicago. In my current research, I am exploring three questions: (1) In rural Nicaragua, where the absence of oral schools for deaf children means that hearing parents provide a different kind of gestural model than do hearing parents of deaf children in the United States, I am asking whether this model makes a difference in the children's homesign systems; (2) In my continuing observation of the gestures that hearing children produce as they learn language, my goal is to figure out the moment when gesture no longer replaces single words but begins to convey larger propositions and thus looks more adult-like; and (3) In studies of whether gesturing plays a role in learning by encouraging children to either gesture or act during instruction, my hypothesis is that because gesture grounds thought in action, it is at least as effective as action (and maybe even more effective) in bringing learning about.

▶ ***What got you interested in studying deaf children's spontaneous sign systems?***
I was interested in where language comes from and whether not having a language would affect the way a person thinks. I therefore wanted to study children who had not been exposed to language, and had heard that deaf children who were orally trained nevertheless used their hands to communicate. This seemed an ideal situation to explore the roots of language. But to explore the effect of language on thinking, I needed to first describe how much of language these deaf children could and could not invent.

▶ ***What has been the real-world impact of this work?***
My studies of gesture in deaf children suggest that children are likely to be expressing themselves in structured ways even if they are not using the language of the community. Clinicians and teachers can use the deaf children's gestures as a starting point for teaching them conventional language, either signed or spoken. More generally, because hearing children often express thoughts in gesture, teachers and parents can use their gestures to find out more about what's on their minds. Because gesturing may itself promote learning, adults can encourage children to gesture in learning situations. At the least, these gestures will give the adults an additional window onto what the children are thinking—and the act of gesturing may itself change the way the children think.

Imagine what it would be like if you had no exposure to language and you wanted to make your desires and thoughts known to another person. How would you get someone to do something as simple as help you open a jar?

You might instinctively turn to your hands—perhaps pointing to the jar and twisting your hand in the air. That is, in fact, the strategy adopted by children who cannot learn the language of their community.

Although many profoundly deaf children are exposed at an early age to a conventional sign language, some are not. These children lack a usable model for language: They can't hear the oral language that their hearing parents are using, and they don't have access to a manual language like American Sign Language. You might guess that, under circumstances such as these, a child would not try to communicate at all. But this guess would be wrong. The child will indeed try to communicate and will use one or both hands to do so. The child will gesture.

What's interesting about this finding, however, is not that deaf children gesture (everyone gestures), but that their gestures have properties in common with natural languages handed down from generation to generation. Indeed, the deaf children's spontaneously invented gestures are similar enough in structure to signed and spoken languages to have earned the label *homesign*. Homesign tells us just how resilient language is in humans.

Using the Hands to Create Language

When deaf children are exposed to sign language from birth, they learn that language as naturally as hearing children learn spoken language. However, 90 percent of deaf children are not born to deaf parents who could provide early access to sign language. Instead, they are born to hearing parents, some of whom choose to expose their children solely to speech. Unfortunately, deaf children with profound hearing losses are unlikely to acquire spoken language, even with specialized instruction.

My colleagues and I have studied 10 profoundly deaf, young homesigners in the United States and 4 in Taiwan (Goldin-Meadow, 2003a), and we're now studying 6 deaf children in Turkey. These children's hearing parents chose to educate them in oral schools where sign language was neither taught nor encouraged, and they had made little progress in oral language. With no exposure to sign language, they knew neither sign nor speech.

Interestingly, homesigners use gesture not only to get others to do things for them (to ask someone to open a jar), but also to share ideas and solicit information (to tell someone about a trip to the zoo or to inquire why a toy isn't working). These children even use their gestures to serve some of the relatively sophisticated functions of language—to tell stories, to comment on their own and others' gestures, and to talk to themselves. In this sense, the children's communications are qualitatively different from those produced by nonhuman primates: Language-trained apes use the signs and symbols they are able to develop only to change people's behavior and not to change their ideas.

In Taiwan, we observed Qing, a deaf child of hearing parents, use her gestures to make a generic statement about swordfish. While looking at a picture of a swordfish, she produced five distinct gestures, illustrated in Figure 1, to make four general propositions about swordfish: They can poke people in the chest (proposition 1) and the people then become dead (proposition 2—the bent index finger is a stylized gesture used by hearing speakers in

FIGURE 1 A Chinese homesigner gesturing about swordfish. The child produces five gestures in response to a picture of a harmless swordfish, who is, in fact, playing a xylophone in the picture (not spearing people): She points at the picture of a swordfish (= *swordfish*). She jabs at her own chest as though piercing her heart (= *poke-in-chest*). She crooks her index finger and wiggles it in the air (this is a stylized gesture in Taiwan that hearing speakers use to mean *dead*). She holds her index finger on her nose and extends it outward (= *long-straight-nose*). She wiggles her palm back and forth (= *swim*). Reprinted from Goldin-Meadow (2003a).

Taiwan to mean *dead*); they have long, straight noses (proposition 3); they swim (proposition 4). After gesturing about swordfish in general, Qing went on to invent a fantasy, motivated perhaps by sibling rivalry. She produced the *poke* gesture again, but this time aimed toward her hearing sister's chest rather than her own, and then gestured *dead*.

This example nicely illustrates two of the many properties of natural language found in homesign: *recursion* (the child has expressed several propositions, each about swordfish, within a single gesture sentence) and *displaced communication* (the child has described events that are not taking place in the here and now).

When attempting to determine which properties of language are found in each deaf child's homesign system, we first describe all of the gestures that the child produces, using a system developed to code the forms of signs in languages like American Sign Language. We then use the form of the gesture and the context in which it's produced to assign a meaning. For example, if a child produces a twisting motion in the air after trying unsuccessfully to open a jar of bubbles, we assign the meaning "twist" to the gesture. If the child relaxes her hand or pauses before producing another gesture, we consider the twist gesture to be a "one-gesture" utterance. If, however, the child does not relax her hand but moves seamlessly into the next gesture, we consider the gestures to be a "two-gesture" string. We thus consider a string of gestures to be a single sentence-like unit if the child does not pause or relax her hand between gestures.

Using this system, we find that the deaf homesigners use their gestures to refer to the same range of objects, people, and places as do (1) young hearing children using words and (2) young, sign language–exposed deaf children using signs—and in the same distribution. They refer most often to inanimate objects, followed by people and animals. They also refer to body parts, food, clothing, vehicles, furniture, and places, but less frequently.

We also find that homesigners frequently combine their gestures with other gestures. They use their gesture strings to convey sentence meanings that are the same as those of hearing children acquiring spoken language from their hearing parents (Brown, 1973) and as those of deaf children acquiring sign language from their deaf parents (Newport & Meier, 1985).

Even though homesigners do not have an explicit model to guide them in constructing their gesture systems, they produce gesture strings that are structured in sentence-like ways. For example, their gesture sentences are consistently ordered—when gesturing about beating a drum, the gesture for the object-acted-upon, the *drum*, will typically precede the gesture for the action, *beat*. In addition (as illustrated in Figure 1), the gesture sentences can be complex, containing several propositions. As another example, we observed a child produce the gesture sentence, *drum beat straw sip*, to describe a scene in which a soldier was beating a drum (proposition 1) and a cowboy was sipping from a straw (proposition 2).

Although they had not observed people signing, the deaf children in our studies were exposed to the gestures that their hearing parents—like all hearing speakers—produce as they talk. These gestures could have served as a model for the structure in the children's gesture systems. To explore this possibility, we analyzed videotapes of the gestures that the hearing mothers of our deaf children produced when talking to the children. However, we looked at them not as they were meant to be experienced (that is, with speech) but with the sound turned off, as the deaf child would see them. Using the analytic tools that we had used to describe the children's gestures, we found that the hearing mothers' gestures did *not* have language-like structure (see, for example, Goldin-Meadow & Mylander, 1998).

In sum, the children received as *input* speech-accompanying gestures that were not language-like in form, but they produced as *output* gestures that resembled language.

Using the Hands to Learn Language

The deaf children in our studies were in a unique situation—most children *are* exposed to a usable model for language from birth and have no trouble acquiring that language. But even children who are acquiring a spoken language like English use gesture and, in fact, many produce gestures several months before they produce their first words. The interesting finding is that hearing children seem to be using their hands to help them learn their language.

The early gestures that children produce not only predate their words, they predict them. For example, the words that will eventually appear in a child's spoken vocabulary can be predicted by looking at that child's earlier pointing gestures (Iverson & Goldin-Meadow, 2005). In fact, one of the best ways to predict the size of a child's spoken vocabulary at 42 months is to look at the number of different meanings the child conveys via gesture at 14 months.

In addition to presaging the shape of children's eventual spoken vocabularies, gesture also paves the way for early sentences. Children combine gestures

with words to express sentence-like meanings (*eat* + point at cookie) months before they can express these same meanings in a word + word combination (*eat cookie*). Importantly, we can predict when a child will first produce a two-word utterance like *eat cookie* just from knowing the age at which that child first produced a gesture + speech combination like *eat* + point at cookie (Iverson & Goldin-Meadow, 2005). Gesture thus serves as a signal that a child will soon be ready to begin producing multi-word sentences.

Moreover, the types of gesture + speech combinations children produce change over time and presage changes in their speech. For example, children produce gesture + speech combinations conveying more than one proposition (akin to a complex sentence, for example, "I like it" + eat gesture) several months before producing a complex sentence entirely in speech ("I like to eat it") (Ozcaliskan & Goldin-Meadow, 2005). Gesture thus continues to be at the cutting edge of early language development, providing stepping-stones to increasingly complex linguistic constructions.

Finding that gesture predicts the child's initial steps into language learning raises the possibility that gesture could help bring that learning about. Gesture has the potential to play a causal role in language learning in at least two ways.

First, children's gestures could elicit from their parents the kinds of words and sentences that the children need to hear in order to take their next linguistic steps. For example, a child who does not yet know the word "dog" might refer to the animal by pointing at it. His obliging mother might say in response to the point, "Yes, that's a dog," thus supplying him with just the word he is looking for.

Or a child in the one-word stage might point at her father while saying "sock." Her mother replies, "That's daddy's sock," thus translating the child's gesture + word combination into a simple (and relevant) sentence. It turns out that mothers often "translate" their children's gestures into words, thus providing timely models for how one- and two-word ideas can be expressed in English (Goldin-Meadow et al., 2007). Gesture thus offers a mechanism by which children can point out their thoughts to others, who then calibrate their speech to those thoughts and potentially facilitate language learning.

The second way in which gesture could play a causal role in language learning is through its cognitive effects (Goldin-Meadow & Wagner, 2005). In studies of older school-aged children solving math problems, we have found that encouraging children to gesture while explaining how they (incorrectly) solved a math problem increases the likelihood that those children will end up learning how to solve the problem correctly. For example, a child who puts 11 in the blank of the problem 5 + 4 + 2 = __ + 2 is more likely to learn that 9 is the correct answer if he is told to move his left hand back and forth under the 5 + 4 + 2 and his right hand back and forth under the __ + 2 than if he is told to produce the verbal equivalent of these gestures: "To solve the problem, I need to make one side equal to the other side" (Cook, Mitchell, & Goldin-Meadow, 2008).

These findings suggest that the act of gesturing can itself promote learning. Extrapolating from these findings, we might predict that, for children in

the early stages of language learning, the act of pointing to an object will increase the likelihood that the pointer will learn a word for that object. Our future work will explore whether gesture can promote language learning not only by allowing children to elicit timely input from their communication partners, but also by directly influencing their own cognitive state.

The Hands Can Provide the First Sign of Developmental Trouble

Because gesture and speech are so tightly intertwined, changes in gesture can predict, and may even help bring about, changes in speech. But what if a child is not following a typical language-learning path? Many, but not all children with pre- or perinatal unilateral brain lesions have early language delays. These early delays are transient for some children but persistent for others. Can we use gesture to predict which children will sustain persistent delays and which children will not?

To find out, we calculated the number of different gestures and words children with brain injury produced during naturalistic interactions with their parents at 18 months, and we then assessed the children's spoken vocabulary on a standardized test at 30 months. Gesture use was highly variable in these children and, importantly, this variability predicted later spoken vocabulary: Children who produced few gesture types at 18 months exhibited delays in vocabulary comprehension 1 year later. Children who produced many gesture types did not (Sauer, Levine, & Goldin-Meadow, 2008).

These findings have both theoretical and practical implications. Theoretically, the fact that gesture and speech remain linked even when different brain structures underlie language functions suggests that early gesture may be inextricably linked to language learning. In terms of practice, the findings suggest that early delays in gesture production can be used to identify children whose language learning is likely to go awry in the future. If so, clinicians can use early gesture diagnostically to identify children likely to have persistent language difficulties well before those difficulties appear in speech. We may therefore be able to offer these children early interventions (perhaps in the form of more intensive gesture instruction).

What Do the Hands Do Once Language Is Learned?

We have seen that children at the earliest stages of learning a spoken language use gestures to stand in for words—a gesture can take the place of a word that a child does not yet have in her spoken vocabulary, and combining gestures with words gives the child a way to express sentence-like meanings before those meanings can be expressed entirely in speech. Importantly, these early uses of gesture predict the entry of particular words into the child's spoken vocabulary and predict the onset of the child's earliest sentences. At the least, early child gesture reflects the child's readiness for learning language. At most, gesture plays a role in the learning process itself, either by eliciting targeted responses from the child's communication partner or by altering the child's own cognitive state.

We have also seen that gesture can function like words for deaf children who have not been exposed to a usable model for language and must invent their own. Gestures act like object-referring words in the homesign systems these deaf children create, and gestures are combined with each other to convey sentence-like meanings in structured ways. But because their gestures must carry the full burden of communication, the homesigning deaf children need to continue to develop their gesture systems—and they do, building more and more linguistic properties into their gesture systems over time (Goldin-Meadow, 2003a).

Hearing children, in contrast, are learning the spoken language that surrounds them. Eventually, they will become proficient language users and will no longer need to substitute gestures for words. But they will continue to gesture. The question is—what form will those gestures take?

Speakers of all ages gesture when they speak, and those gestures are integrated both temporally and semantically with the speech they accompany (McNeill, 1992; Kendon, 1980). The gestures produced by proficient spoken-language users are comparable to those of children on the cusp of spoken language in that, at times, they convey information that is different from that conveyed in speech. Interestingly, the occurrence of such gestures is similar in both groups: They are used most frequently when describing things that the speaker is on the verge of learning (Goldin-Meadow, 2003b).

Note, however, that the task facing the young, hearing language-learner is spoken language itself. Thus, in these early stages, the gesture is used as an assist into the linguistic system, substituting for spoken words that the child has not yet acquired. But once the basics of spoken language have been mastered, gesture is freed up for other purposes—for example, to frame the discourse (McNeill, 1992) or to help speakers grapple with ideas that they are having difficulty expressing in speech, ideas that rarely translate into a single word (see, for example, the math task described earlier). As a result, we see a change in the kinds of ideas expressed in gesture as children become proficient users of spoken language. But at every stage, the gestures that accompany speech serve to enrich the ideas that speakers express.

To summarize, when young children do not have a model for language, they use gesture to fill the void. Even when children do have a model for language, they use gesture to help them take steps into language that they cannot yet take in speech. Indeed, gesturing may actually facilitate children's transition to language. The hands thus set the stage for language, be it created or learned.

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Suggested Further Reading

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