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GESTURE'S ROLE IN CREATING AND LEARNING LANGUAGE

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Abstract

Imagine a child who has never seen or heard language. Would such a child be able to invent a language? Despite what one might guess, the answer is "yes". This chapter describes children who are congenitally deaf and cannot learn the spoken language that surrounds them. In addition, the children have not been exposed to sign language, either by their hearing parents or their oral schools. Nevertheless, the children use their hands to communicate—they gesture—and those gestures take on many of the forms and functions of language (Goldin-Meadow 2003a). The properties of language that we find in these gestures are just those properties that do not need to be handed down from generation to generation, but can be reinvented by a child de novo. They are the resilient properties of language, properties that all children, deaf or hearing, come to language-learning ready to develop.

In contrast to these deaf children who are inventing language with their hands, hearing children are learning language from a linguistic model. But they too produce gestures, as do all hearing speakers (Feyereisen and de Lannoy 1991; Goldin-Meadow 2003b; Kendon 1980; McNeill 1992). Indeed, young hearing children often use gesture to communicate before they use words. Interestingly, changes in a child's gestures not only predate but also predict changes in the child's early language, suggesting that gesture may be playing a role in the language-learning process.

This chapter begins with a description of the gestures the deaf child produces without speech. These gestures assume the full burden of communication and take on a language-like form—they are language. This phenomenon stands in contrast to the gestures hearing speakers produce with speech. These gestures share the burden of communication with speech and do not take on a language-like form—they are part of language.

Gesture produced without speech can become language

When deaf children are exposed to sign language from birth, they learn that language as naturally as hearing children learn spoken language (Newport and Meier 1985). However, 90% of deaf children are not born to deaf parents who could provide early access to sign language. Rather, they are born to hearing parents who, quite naturally, expose their children to speech. Unfortunately, it is extremely uncommon for deaf children with severe to profound hearing losses to acquire spoken language without intensive and specialized instruction. Even with instruction, their acquisition of speech is markedly delayed (Conrad 1979; Mayberry 1992).

The ten children my colleagues and I studied were severely to profoundly deaf (Goldin-Meadow 2003a). Their hearing parents had decided to educate them in oral schools where sign systems are neither taught nor encouraged. At the time of our observations, the children ranged in age from 1;2 to 4;10 (years;months) and had made little progress in oral language, occasionally producing single words but never combining those words into sentences. In addition, they had not been exposed to a conventional sign system of any sort (e.g., American Sign Language or a manual code of English). The children thus knew neither sign nor speech.

Under such inopportune circumstances, these deaf children might be expected to fail to communicate, or perhaps to communicate only in non-symbolic ways. The impetus for symbolic communication might require a language model, which all of these children lacked. However, this turns out not to be the case. Many studies have shown that deaf children will spontaneously use gestures – called "homesigns" – to communicate if they are not exposed to a conventional sign language (Fant 1972; Lenneberg 1964; Moores 1974; Tervoort 1961). Children who use gesture in this way are clearly communicating. But are they communicating in a language-like way? The focus of my work has been to address this question. I do so by identifying linguistic constructions that the deaf children use in their gesture systems. These properties of language, which the children are able to fashion without benefit of linguistic input, are what I call the "resilient" properties of language (Goldin-Meadow 1982; 2003a).

The resilient properties of language

I describe below the resilient properties of language that we have found thus far in the ten deaf children's gesture systems (Goldin-Meadow 2003a). There may, of course, be many others – just because we haven't found a particular property in a deaf child's homesign gesture system doesn't mean it's not there. We have found properties at the word- and sentence-levels, as well as properties of language use.

Words

The deaf children's gesture words have many properties that are found in the words of all natural languages. The gestures are *stable* in form, although they needn't be. It would be easy for the children to make up a new gesture to fit every new situation (and, indeed, that appears to be what hearing speakers do when they gesture along with their speech, cf. McNeill 1992). But that's not what the deaf children do. They develop a stable store of forms that they use in a range of situations – they develop a lexicon, an essential component of all languages (Goldin-Meadow, Butcher, Mylander and Dodge 1994).

Moreover, the gestures the children develop are composed of parts that form *paradigms*, or systems of contrasts. When the children invent a gesture form, they do so with two goals in mind – the form must not only capture the meaning they intend (a gesture-world relation), but it must also contrast in a systematic way with other forms in their repertoire (a gesture-gesture relation). In addition, the parts that form these paradigms are *categorical*. For example, one child used a *Fist* handshape to represent grasping a balloon string, a drumstick, and handlebars – grasping actions requiring considerable variety in diameter in the real world. The child did not distinguish objects of varying diameters within the *Fist* category, but did use his handshapes to distinguish objects with small diameters as a set from objects with large diameters (e.g., a cup, a guitar neck, the length of a straw), which were represented by a *CLarge* hand. The manual modality can easily support a system of analog representation, with hands and motions reflecting precisely the positions and trajectories used to act on objects in the real world. But the children don't choose this route. They develop categories of meanings that, although essentially iconic, have hints of *arbitrariness* about them (the children don't, for example, all have the same form-meaning pairings for handshapes, Goldin-Meadow, Mylander and Butcher 1995; Goldin-Meadow, Mylander and Franklin 2007).

Finally, the gestures the children develop are differentiated by *grammatical function*. Some serve as nouns, some as verbs, some as adjectives. As in natural languages, when the same gesture is used for more than one grammatical function, that gesture is marked (morphologically and syntactically) according to the function it plays in the particular sentence (Goldin-Meadow *et al* 1994). For example, if a child were to use a twisting gesture

in a verb role, that gesture would likely be produced near the jar to be twisted open (i.e., it would be inflected), it would *not* be abbreviated, and it would be produced *after* a pointing gesture at the jar. In contrast, if the child were to use the twisting gesture in a noun role, the gesture would likely be produced in neutral position near the chest (i.e., it would *not* be inflected), it would be abbreviated (produced with one twist rather than several), and it would occur *before* the pointing gesture at the jar.

Sentences

The deaf children's gesture sentences have a variety of sentential properties found in all natural languages. Underlying each sentence is a *predicate frame* that determines how many arguments can appear along with the verb in the surface structure of that sentence (Goldin-Meadow 1985). For example, four slots underlie a gesture sentence about transferring an object, one for the verb and 3 for the arguments (actor, patient, recipient). In contrast, three slots underlie a gesture sentence about eating an object, one for the verb and 2 for the arguments (actor, patient).

Moreover, the arguments of each sentence are marked according to the thematic role they play. There are three types of markings that are resilient (Goldin-Meadow and Mylander 1984; Goldin-Meadow *et al* 1994):

1. *Deletion* – The children consistently produce and delete gestures for arguments as a function of thematic role; for example, they are more likely to delete a gesture for the object or person playing the role of transitive actor (soldier in "soldier beats drum") than they are to delete a gesture for an object or person playing the role of intransitive actor (soldier in "soldier marches to wall") or patient (drum in "soldier beats drum").
2. *Word order* – The children consistently order gestures for arguments as a function of thematic role; for example, they place gestures for intransitive actors and patients in the first position of their two-gesture sentences (soldier-march; drum-beat).
3. *Inflection* – The children mark with inflections gestures for arguments as a function of thematic role; for example, they displace a verb gesture in a sentence toward the object that is playing the patient role in that sentence (the "beat" gesture would be articulated near, but not on, a drum).

In addition, *recursion*, which gives natural languages their generative capacity, is a resilient property of language. The children form complex gesture sentences out of simple ones (Goldin-Meadow 1982). For example, one child pointed at me, produced a "wave" gesture, pointed again at me, and then produced a "close" gesture to comment on the fact that I had waved before closing the door – a complex sentence containing two propositions: "Susan waves" (proposition 1) and "Susan closes door" (proposition 2). The children systematically combine the predicate frames underlying each simple sentence, following principles of sentential and phrasal conjunction. When there are semantic elements that appear in both propositions of a complex sentence, the children have a systematic way of *reducing redundancy*, as do all natural languages (Goldin-Meadow 1982; 1987).

Language use

The deaf children use their gestures for many of the central functions that all natural languages serve. They use gesture to make requests, comments, and queries about things and events that are happening in the situation – that is, to communicate about the *here-and-now*. Importantly, however, they also use their gestures to communicate about the non-present –

displaced objects and events that take place in the past, the future, or in a hypothetical world (Butcher, Mylander and Goldin-Meadow 1991; Morford and Goldin-Meadow 1997).

In addition to these rather obvious functions that language serves, the children use their gestures to communicate with themselves – to *self-talk* (Goldin-Meadow 2003a). They also use their gestures to refer to their own or to others' gestures – for *metalinguistic* purposes (Singleton, Morford and Goldin-Meadow 1993). And finally, the children use their gestures to tell stories about themselves and others – to *narrate* (Phillips, Goldin-Meadow and Miller 2001). They tell stories about events they or others have experienced in the past, events they hope will occur in the future, and events that are flights of imagination. For example, in response to a picture of a car, one child produced a "break" gesture, an "away" gesture, a pointing gesture at his father, a "car-goes-onto-truck" gesture. He paused and produced a "crash" gesture and repeated the "away" gesture. The child was telling us that his father's car had crashed, broken, and gone onto a tow truck. Note that, in addition to producing gestures to describe the event itself, the child produced what we have called a narrative marker – the "away" gesture, which marks a piece of gestural discourse as a narrative in the same way that "once upon a time" is often used to signal a story in spoken discourse.

Do gestures produced with speech serve as a model for gestures produced without speech?

The deaf children we study are not exposed to a conventional sign language and thus cannot be fashioning their gestures after such a system. They are, however, exposed to the gestures that their hearing parents use when they speak. These gestures are likely to serve as relevant input to the gesture systems that the deaf children construct. The question is what does this input look like and how do the children use it?

We first ask whether the gestures that the hearing parents use with their deaf children exhibit the same structure as their children's gestures. If so, these gestures could serve as a model for the deaf children's system. If not, we have an opportunity to observe how the children transform the input they do receive into a system of communication that has many of the properties of language.

The hearing parents' gestures are not structured like their deaf children's

Hearing parents gesture when they talk to young children (Bekken 1989; Shatz 1982; Iverson, Capirci, Longobardi and Caselli 1999) and the hearing parents of our deaf children are no exception. The deaf children's parents were committed to teaching them to talk and therefore talked to their children as often as they could. And when they talked, they gestured.

We looked at the gestures that the hearing mothers produced when talking to their deaf children. However, we looked at them not as they were meant to be looked at, but as a deaf child might look at them. We turned off the sound and analyzed the gestures using the same analytic tools that we used to describe the deaf children's gestures (Goldin-Meadow and Mylander 1983; 1984). We found that the hearing mothers' gestures do not have structure when looked at from a deaf child's point of view.

We find no evidence of structure at any level in the mothers' gestures. With respect to gestural "words," the mothers did not have a *stable* lexicon of gestures (Goldin-Meadow *et al* 1994); nor were their gestures composed of *categorical* parts that formed *paradigms* (Goldin-Meadow *et al* 1995) or varied with *grammatical function* (Goldin-Meadow *et al* 1994). With respect to gestural "sentences," the mothers rarely concatenated their gestures into strings and thus provided little data from which we (or their deaf children, for that

matter) could abstract *predicate frames* or *deletion, word order,* and *inflectional* marking patterns (Goldin-Meadow and Mylander 1984). Whereas all of the children produce complex sentences displaying *recursion*, only some of the mothers did and they first produced these sentence types later than their children (Goldin-Meadow 1982). With respect to gestural use, the mothers did not make *displaced reference* with their gestures (Butcher *et al* 1991), nor did we find evidence of any of the other uses to which the children put their gestures, including *story-telling* (e.g., Phillips *et al* 2001).

Of course, it may be necessary for the deaf children to see hearing people gesturing in communicative situations in order to get the idea that gesture can be appropriated for the purposes of communication. However, in terms of how the children *structure* their gestured communications, there is no evidence that this structure comes from the children's hearing mothers. Thus, although the deaf children may be using hearing peoples' gestures as a starting point, they go well beyond that point – transforming the gestures they see into a system that looks very much like language.

Exploring the deaf child's transformation of gesture into homesign

How can we learn more about this process of transformation? The fact that hearing speakers across the globe gesture differently when they speak affords us with an excellent opportunity to explore if – and how – deaf children make use of the gestural input that their hearing parents provide. For example, the gestures that accompany Turkish and Spanish look very different from those that accompany English and Mandarin. As described by Talmy (1985), Spanish and Turkish are verb-framed languages whereas English and Mandarin are satellite-framed languages (Talmy 1985). This distinction depends primarily on the way in which the path of a motion is packaged. In a satellite-framed language, both path and manner can be encoded within a verbal clause; manner is encoded in the verb itself (*flew*) and path is coded as an adjunct to the verb, a satellite (e.g., *down* in the sentence "the bird flew down"). In a verb-framed language, path is bundled into the verb while manner is introduced constructionally outside the verb, in a gerund, a separate phrase, or clause (e.g., if English were a verb-framed language, the comparable sentence would be "the bird exits flying"). One effect of this typological difference is that manner can, depending upon pragmatic context (Allen *et al* 2005; Papafragou and Gleitman 2006), be omitted from sentences in verb-framed languages (Slobin 1996).

However, McNeill (1998) has observed an interesting compensation – although manner is omitted from Spanish-speakers' *talk*, it frequently crops up in their *gestures*. Moreover, and likely because Spanish-speakers' manner gestures do not co-occur with a particular manner word, their gestures tend to spread through multiple clauses (McNeill 1998). As a result, Spanish-speakers' manner gestures are longer and may be more salient to a deaf child than the manner gestures of English- or Mandarin-speakers. Turkish-speakers also produce gestures for manner relatively frequently, producing more manner *only* gestures (e.g., fingers wiggling in place to represent feet alternating while walking) than English speakers, who produce more gestures containing *both* manner and path (fingers wiggling as the hand crosses space; Kita and Özyürek 2003; Özyürek and Kita 1999; Özyürek *et al* 2007). These gestural patterns can be traced to the typological difference between English and Turkish – manner and path are expressed in separate clauses in Turkish but in the same clause in English. Manner-only gestures are thus less frequent in English- and Mandarin-speakers than in Spanish- and Turkish-speakers.

These four cultures – Spanish, Turkish, American, and Chinese – thus offer an excellent opportunity to examine the effects of hearing speakers' gestures on the gesture systems developed by deaf children. Our plan in future work is to take advantage of this opportunity. If deaf children in all four cultures develop gesture systems with the same structure despite

wide differences in the gestures they see, we will have strong evidence of the biases children themselves must bring to a communication situation. If, however, the children differ in the gesture systems they construct, we will be able to explore how a child's construction of a language-like gesture system can be influenced by the gestures he or she sees. We have already found that American deaf children exposed only to the gestures of their hearing English-speaking parents create gesture systems that are very similar in structure to the gesture systems constructed by Chinese deaf children exposed to the gestures of their hearing Mandarin-speaking parents (Goldin-Meadow and Mylander 1998). The question now is whether these children's gesture systems are different from those of Spanish and Turkish deaf children of hearing parents.

An experimental manipulation of gesture with and without speech

The hearing mothers of each of the deaf children in our studies were committed to teaching their children to speak. As a result, they never gestured without talking. And, like all speakers' gestures, the gestures that the hearing mothers produced formed an integrated system with the speech they accompanied (McNeill 1992). The mothers' gestures were thus constrained by speech and were not "free" to take on the resilient properties of language found in their children's gestures. The obvious question is what would happen if we forced the mothers to keep their mouths shut.

We did just that – although the participants in our study were undergraduates at the University of Chicago, not the deaf children's hearing mothers (Goldin-Meadow, McNeill and Singleton 1996). We asked English-speakers who had no previous experience with sign language to describe a series of videotaped scenes using their hands and not their mouths. We then compared the resulting gestures to the gestures these same adults produced when asked to describe the scenes using speech.

We found that when using gesture on its own, the adults frequently produced discrete gestures and combined those gestures into strings. Moreover, the strings were reliably ordered, with gestures for certain semantic elements occurring in particular positions in the string; that is, there was structure across the gestures at the sentence level. In addition, the verb-like action gestures that the adults produced when using gesture on its own could be divided into handshape and motion parts, with the handshape of the action frequently conveying information about the objects in its semantic frame; that is, there was some structure within the gesture at the word level. Importantly, these properties did not appear in the gestures that these same adults produced along with speech. Thus, only when asked to use gesture on its own did the adults produced gestures characterized by segmentation and combination. Moreover, they constructed these gesture combinations with essentially no time for reflection on what might be fundamental to language-like communication.

The adults might have gotten the inspiration to order their gestures from their own English language. However, the particular order that they used in their gestures did *not* follow canonical English word order. For example, adults were asked to describe a doughnut-shaped object that arcs out of an ashtray. When using gesture without speech, the adults produced a gesture for the ashtray first, followed by a gesture for the doughnut, and finally a gesture for the arcing-out action (Goldin-Meadow *et al* 1996; Gershkoff-Stowe and Goldin-Meadow 2002). Note that a typical description of this scene in English would follow a different order: "The doughnut arcs out of the ashtray."

To explore the generality of this phenomenon, we asked speakers of four languages differing in their predominant word orders (English, Turkish, Spanish, Chinese) to describe events using gesture without speech). We found that the word orders the speakers used in their everyday speech did *not* influence their gestures — speakers of all four languages used the

same gesture order. For example, to describe a captain swinging a pail, the adults produced a gesture for the captain (Actor), then produced a gesture for the pail (Patient), and finally a gesture for the swinging action (Act), that is, an Actor-Patient-Act (ArPA) order. The ArPA order was also found when a different group of speakers of the same four languages were asked to reconstruct the events using transparent pictures. The adults were given no indication that the order in which they stacked the transparencies was the focus of the study; in fact, the background of each transparency was clear so that the final product looked the same independent of the order in which the transparencies were stacked. Nevertheless, the adults tended to pick up the transparency for the Actor, followed by the transparency for the Patient, and finally the transparency for the Act, thus again displaying the ArPA order (Goldin-Meadow *et al* 2008). Note that the deaf children inventing their own homesign systems tended to place gestures for Patients before gestures for Acts (the children frequently omitted gestures for Actors in transitive relations). Moreover, ArPA is the order currently emerging in a sign language created spontaneously without any apparent external influence. Al-Sayyid Bedouin Sign Language arose within the last 70 years in an isolated community with a high incidence of profound prelingual deafness. In the space of one generation, the language assumed grammatical structure, including ArPA order (Sandler, Meir, Padden and Aronoff 2005).

Although the adults in our studies incorporated many linguistic properties into the gestures they produced when using gesture on its own, they did not develop all of the properties found in natural language, or even all of the properties found in the gesture systems of the deaf children. In particular, they failed to develop a system of internal contrasts in their gestures. When incorporating handshape information into their action gestures, they rarely used the same handshape to represent an object, unlike the deaf child whose handshapes for the same objects were consistent in form and in meaning (Singleton, Morford and Goldin-Meadow 1993). Thus, a system of contrasts in which the form of a symbol is constrained by its relationship to other symbols in the system (as well as by its relationship to its intended referent) is *not* an immediate consequence of symbolically communicating information to another. The continued experience that the deaf children had with a stable set of gestures (cf. Goldin-Meadow *et al* 1994) may be required for a system of contrasts to emerge in those gestures.

In sum, when gesture is called upon to fulfill the communicative functions of speech, it immediately takes on the properties of segmentation and combination that are characteristic of speech. The appearance of these properties in the adults' gestures is particularly striking given that these properties were *not* found in the gestures that these same adults produced when asked to describe the scenes in speech. When the adults produced gestures along with speech, they rarely combined those gestures into strings and rarely used the shape of the hand to convey any object information at all (Goldin-Meadow *et al* 1996). In other words, they did not use their gestures as building blocks for larger units, either sentence or word units. Rather, they used their gestures to holistically and mimetically depict the scenes in the videotapes, as speakers typically do when they spontaneously gesture along with their talk, a topic to which we now turn, focusing in particular on the gestures children produce during the early stages of language learning.

Gesture produced with speech is part of language

Months before hearing children are able to produce words to refer to people, places, and things, they gesture (Acredolo and Goodwyn 1985; 1989; Bates 1976; Bates *et al* 1979). Young children often point at objects for which they do not yet have words. Interestingly, the fact that a child has pointed at an object increases the likelihood that the child will learn a word for that object within the next few months, suggesting that early gesture may pave

the way for later word learning (Iverson and Goldin-Meadow 2005). In addition, children use iconic or conventional gestures that convey action information (e.g., moving the hand repeatedly to mouth to convey eating; extending an open palm next to a desired object to indicate give).

In addition to expanding children's vocabularies, gesture also paves the way for their early sentences. Children combine pointing 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, the age at which children first produce gesture + speech combinations of this sort reliably predicts the age at which they first produce two-word utterances (Goldin-Meadow and Butcher 2003; Iverson and Goldin-Meadow 2005; Iverson *et al* 2008). 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 children's speech (Özcalıskan and Goldin-Meadow 2005). For example, children produce gesture + speech combinations conveying more than one proposition (akin to a complex sentence, e.g., "I like it" + eat gesture) several months before producing a complex sentence entirely in speech ("I like to eat it"). 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 be instrumental in bringing that learning about. Gesture has the potential to play a causal role in language learning in at least two non-mutually exclusive 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 "cat" might refer to the animal by pointing at it. His mother might say in response to the point, "yes, that's a cat," 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 "cup." Her mother replies, "that's daddy's cup," 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 and Wagner 2005). Work on older school-aged children solving math problems has found that encouraging children to produce gestures conveying a correct problem-solving strategy increases the likelihood that those children will learn to solve the problem correctly (Cook and Goldin-Meadow 2006; Goldin-Meadow, Cook and Mitchell 2008; see also Broaders *et al* 2007 and Cook, Mitchell and Goldin-Meadow 2007). These findings suggest that the act of gesturing can promote learning. Similarly, when learning language, the act of pointing to an object might itself make it more likely that the pointer will learn a word for that object. Future work is needed to 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.

Conclusions

Gesture is chameleon-like in its form and that form is tied to the function the gesture is serving. When gesture assumes the full burden of communication, acting on its own without

speech, it takes on a language-like form, even when the gesturer is a young child who has not had access to a usable model of a conventional language. As such, gesture can reveal the linguistic biases that children bring to the task of communication and may be the best window we have onto those biases. Interestingly, however, when gesture shares the burden of communication with speech, it loses its language-like structure, assuming instead a holistic and unsegmented form. Although not language-like in structure when it accompanies speech, gesture still forms an important part of language. As such, it can tell us when children are ready to learn language and may even play a role in facilitating the learning. Gesture can be *part of* language or can itself *be* language and thus sheds light on what it means to be a language.

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