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How gesture helps children learn language*

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Children gesture before they begin to speak and continue gesturing throughout the language learning process. This chapter focuses on those gestures, and explores the role they play in language learning. We find that children's early gestures not only precede, but also predict, the onset of a number of linguistic milestones—nouns, nominal constituents, simple and complex sentences. Gesturing may thus play a causal role in language learning, and could do so in two ways: (1) Gesturing gives children the opportunity to practice expressing ideas in a preverbal form. (2) A child's gestures offer parents and other communication partners insight into the child's linguistic level, thus giving the partners the opportunity to provide input tailored to that level.

A personal note

Eve Clark has been one of the most eloquent proponents of the view that language is learned on the ground—that is, in day-to-day interactions with parents and peers. She, more than any other researcher, has convinced the field that children learn language in interaction, and she has done so by describing in exquisite detail the properties, and the implications, of those interactions. Happily for the field of gesture researchers, gesture is one of the behaviors to which Eve has turned her attention. And she has found that gesture is a behavior adults use to inform young children about new word meanings. My focus in this chapter is on the gestures that

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children themselves use,¹ and whether they too can play a role in language learning. We will see that children's gestures not only precede, but also predict, their acquisition of linguistic milestones and, more importantly from the perspective that Eve has taken, children's gestures often let parents know exactly what input they need to hear to take the next step toward a linguistic milestone. As Eve would predict, gesture is one of the behaviors that can help children learn language on the ground.

Gesture selectively predicts different linguistic milestones

At a time in development when children are limited in the words they know and use, gesture offers a way to extend their communicative range. Children typically begin to gesture between 8 and 12 months (Bates, 1976; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979), first producing deictic gestures (pointing at objects, people, and places in the immediate environment, or holding up objects to draw attention to them), and later producing iconic gestures that capture aspects of the objects, action or attributes they represent (e.g., flapping arms to refer to a bird or to flying, Iverson, Capirci, & Caselli, 1994). The fact that gesture allows children to communicate meanings that they do not yet express in speech opens up the possibility that gesturing itself facilitates language learning. If so, changes in gesture should not only predate, but they should also predict, changes in language. And they do, both for words and for sentences (see Table 1).

Table 1. Examples of linguistic constructions preceded and predicted by gesture.

Type of construction	Preceding Construction Containing Gesture	Subsequent Construction Containing Speech Alone
<i>Nouns</i>	point at bottle	"bottle"
<i>Nominal constituents</i>	point at dog + "dog"	"the dog"
<i>Simple sentences</i>		
Argument + Argument (entity-location)	"daddy" + point at dirt on floor	"mommy in kitchen"
Argument + Predicate (agent-act)	"you" + HIT gesture	"I paint"
Argument + Predicate (act-patient)	"drive" + point at car	"ride horsie"
<i>Complex sentences</i>		
Predicate + Predicate	"I like it" + EAT gesture	"help me find"

1. I focus here on the spontaneous gestures that children produce, rather than the codified gestures, called *baby signs*, that many parents teach their children before they are able to speak (Johnston, Durieux-Smith, & Bloom, 2005; Kirk, Howlett, Pine, & Fletcher, 2013).

Words: nouns and verbs

The more a child gestures early on, the more words are likely to be present in the child's vocabulary later in development (Acredolo & Goodwyn, 1988; Rowe, Özçaliskan, & Goldin-Meadow, 2008; Rowe & Goldin-Meadow, 2009a; Colonnese, Stams, Koster, & Noom, 2010). Even more compelling, we can predict which particular nouns will enter a child's verbal vocabulary by looking at the objects that child indicated using deictic gestures several months earlier (Iverson & Goldin-Meadow, 2005). For example, a child who does not know the word "dog," but communicates about dogs by pointing at them is likely to learn the word "dog" within three months (Iverson & Goldin-Meadow, 2005). Gesture paves the way for children's early nouns.

However, gesture does not appear to pave the way for early verbs – although we might have expected iconic gestures that depict actions to precede, and predict, the onset of verbs, they do not. Özçaliskan, Gentner, and Goldin-Meadow (2013) observed spontaneous speech and gestures in 40 English-learning children from age 14 to 34 months, and found that the children produced their first iconic gestures 6 months *later* than their first verbs. The onset of iconic gestures conveying action meanings thus followed, rather than preceded, children's first verbs². But iconic gestures did increase in frequency at the same time that verbs did and, at that time, children used these action gestures to convey specific verb meanings that they were not yet expressing in speech. Children thus do use gesture to expand their repertoire of verb meanings, but only *after* they have begun to acquire the verb system underlying their language.

Onset of sentences

Even though they treat gestures like words in some respects, children very rarely combine their gestures with other gestures, and if they do, the phase tends to be short-lived (Goldin-Meadow & Morford, 1985). But children do often combine their gestures with words, and they produce these gesture + speech combinations well before they produce word + word combinations. Children's earliest gesture + speech combinations contain gestures that convey information that *complements* the information conveyed in speech; for example, pointing at a ball while saying "ball" (Capirci, Iverson, Pizzuto, & Volterra, 1996; de Laguna, 1927; Greenfield & Smith, 1976; Guillaume, 1927; Leopold, 1939-49). Soon after,

2. Estigarribia and Clark (2007) have found that pointing gestures attract and maintain attention in talk differently from iconic (or, in their terms, demonstrating) gestures, which may account for the fact that pointing gestures predict the onset of nouns, but iconic gestures do not predict the onset of verbs.

children begin to produce combinations in which gesture conveys information that is different from and *supplements* the information conveyed in the accompanying speech; for example, pointing at a ball while saying “here” to request that the ball be moved to a particular spot (Goldin-Meadow & Morford, 1985; Greenfield & Smith, 1976; Masur, 1982, 1983; Morford & Goldin-Meadow, 1992; Zinober & Martlew, 1985).

As in the acquisition of words, we find that changes in gesture (in this case, changes in the relationship gesture holds to the speech it accompanies) predict changes in language (the onset of sentences). The age at which children first produce *supplementary* gesture + speech combinations (e.g., point at cup + “drink”) reliably predicts the age at which they first produce two-word utterances (e.g., “drink cup”) (Goldin-Meadow & Butcher, 2003; Iverson, Capirci, Volterra, & Goldin-Meadow, 2008; Iverson & Goldin-Meadow, 2005). The age at which children first produce *complementary* gesture + speech combinations (e.g., point at cup + “cup”) does not. Moreover, supplementary combinations selectively relate to the syntactic complexity of children’s later sentences. Rowe and Goldin-Meadow (2009b) observed 52 children from families reflecting the demographic range of Chicago and found that the number of supplementary gesture + speech combinations the children produced at 18 months reliably predicted the complexity of their sentences (as measured by the IPSyn, Scarborough, 1990) at 42 months, but the number of different meanings they conveyed in gesture at 18 months did not. Conversely, the number of different meanings children conveyed in gesture at 18 months reliably predicted their spoken vocabulary (as measured by the PPVT, Dunn & Dunn, 1997) at 42 months, but the number of supplementary gesture + speech combinations they produced at 18 months did not. Gesture is thus not merely an early index of global communicative skill, but is a harbinger of specific linguistic steps children will soon take—early gesture words predict later spoken vocabulary, and early gesture sentences predict later spoken syntax.

Onset of different constructions

Gesture does more than open the door to sentence construction—the particular gesture + speech combinations children produce predict the onset of corresponding linguistic milestones. Özçalışkan and Goldin-Meadow (2005) observed 40 of the children in the Rowe and Goldin-Meadow (2009b) sample at 14, 18, and 22 months, and found that the types of supplementary combinations the children produced changed over time and, critically, presaged changes in their speech. For example, the children began producing “two-verb” complex sentences in gesture + speech combinations (“I like it” + EAT gesture) several months before they produced complex sentences entirely in speech (“help me find it”). Supplementary

gesture + speech combinations thus continue to provide stepping-stones to increasingly complex linguistic constructions.

As mentioned earlier, the age at which children first produce *complementary* gesture + speech combinations in which gesture indicates the object labeled in speech (e.g., point at cup + “cup”) does not reliably predict the onset of two-word utterances (Iverson & Goldin-Meadow, 2005), reinforcing the idea that it is the specific way in which gesture is combined with speech, rather than the ability to combine gesture with speech *per se* that signals the onset of future linguistic achievements. The gesture in a complementary gesture + speech combination has traditionally been considered redundant with the speech it accompanies but, as Clark and Estigarribia (2011) show, gesture typically locates the object being labeled and, in this sense, has a different function from speech. Complementary gesture + speech combinations have, in fact, recently been found to point forward—but to the onset of nominal constituents rather than the onset of sentential constructions. If children are using nouns to classify the objects they label (as recent evidence suggests infants do when hearing spoken nouns; Parise & Csibra, 2012), then producing a complementary point with a noun could serve to specify an instance of that category. In this sense, a pointing gesture could be functioning like a determiner. Cartmill, Hunsicker, and Goldin-Meadow (2014) analyzed all of the utterances containing nouns produced by 18 children in the Rowe and Goldin-Meadow (2009b) sample, and focused on (1) utterances containing an unmodified noun combined with a complementary pointing gesture (e.g. point at cup + “cup”), and (2) utterances containing a noun modified by a determiner (e.g., “the/a/that cup”). They found that the age at which children first produced complementary point + noun combinations selectively predicted the age at which the children first produced determiner + noun combinations. Not only did complementary point + noun combinations precede and predict the onset of determiner + noun combinations in speech, but these point + noun combinations also decreased in number once children gained productive control over determiner + noun combinations. When children point to and label an object simultaneously, they appear to be on the cusp of developing an understanding of nouns as a modifiable unit of speech.

Gesture has also been found to predict changes in narrative structure later in development. In Demir, Levine, and Goldin-Meadow (under review), 38 children from Rowe and Goldin-Meadow (2009b) were asked to retell a cartoon at age 5 and then again at ages 6, 7, and 8. Although their narrative structure continued to improve over the 4-year period, the children showed little evidence of framing their narratives from a character’s perspective in speech even at age 8. However, at age 5, many of the children were able to take a character’s viewpoint into account in gesture. For example, to describe a woodpecker’s actions, a child moves her upper body and head back and forth, thus assuming the perspective of the bird (as

opposed to moving a beak-shaped hand back and forth and thus taking the perspective of someone looking at the bird, cf. McNeill, 1992). Moreover, the children who produced character-viewpoint gestures at age 5 were more likely than children who did not produce character-viewpoint gestures to produce well-structured stories in the later years. Gesture thus continues to act as a harbinger of change as it assumes new roles in relation to discourse and narrative structure.

Fleshing out constructions

Gesture does not, however, always predict transitions in language learning. Gesture precedes and predicts linguistic developments when those developments involve *new* constructions, but not when the developments involve fleshing out existing constructions. For example, Özçalışkan and Goldin-Meadow (2009) observed 40 children in the Rowe and Goldin-Meadow (2009b) sample and found that the children produced combinations in which speech conveyed a predicate and gesture conveyed an argument (e.g., WASH gesture + “hair” = predicate in gesture, object in speech) several months before they produced predicate + argument combinations entirely in speech (e.g., “popped this balloon” = predicate, object, both in speech). However, once the basic predicate + argument construction had been acquired in speech, the children did not rely on gesture to add arguments to the predicate frame. Thus, the children produced their first predicate + 2 argument combinations in speech (e.g., “I want the Lego” = agent, predicate, object, all in speech) and in gesture + speech (point at father + “have food” = agent in gesture, predicate and object in speech) at the same age (Özçalışkan & Goldin-Meadow, 2009).

Why does early gesture selectively predict later spoken vocabulary size and sentence complexity? At the least, gesture reflects two separate abilities (word learning and sentence making) on which later linguistic abilities can be built. Expressing many different meanings in gesture early in development is a sign that the child is going to be a good vocabulary learner, and expressing many different types of gesture + speech combinations is a sign that the child is going to be a good sentence learner. The early gestures children produce thus reflect their cognitive potential for learning particular aspects of language. But early gesture could be doing more—it could be helping children realize their potential. In other words, the act of expressing meanings in gesture could be playing an active role in helping children become better vocabulary learners, and the act of expressing sentence-like meanings in gesture + speech combinations could be playing an active role in helping children become better sentence learners. The next section explores this possibility.

The mechanisms underlying gesture's role in language learning

Gesture provides opportunities to practice conveying meanings

Child gesture could have an impact on language learning in at least two ways. First, gesture gives children an opportunity to practice producing particular meanings by hand at a time when those meanings are difficult to express by mouth. We know, for example, that early gesture use is related to later vocabulary size. In a mediation analysis, Rowe and Goldin-Meadow (2009a) found that the relatively large vocabularies children from high SES families display at 54 months can be partially explained by child gesture use at 14 months. In turn, child gesture use at 14 months can be explained by parent gesture use at 14 months, even when parent speech is controlled. Importantly, parent gesture does not appear to have a direct effect on subsequent child spoken vocabulary--the effect is mediated through child gesture, suggesting that it is the act of gesturing on the part of the child that is critical.

Although these findings suggest that child gesture is playing a causal role in language learning, we need to manipulate gesture to be certain of this claim. Previous work has found that telling 9- and 10-year-old children to gesture when explaining how they solved a math problem does, in fact, make them particularly receptive to subsequent instruction on that problem--the gesturing itself appears to be responsible for their improved performance after instruction (Broaders, Cook, Mitchell, & Goldin-Meadow, 2007). As another example more relevant to language learning, LeBarton, Raudenbush, and Goldin-Meadow (in press) studied 15 toddlers (beginning at 17 months) in an 8-week at-home intervention study (6 weekly training sessions plus follow-up 2 weeks later) in which all children were exposed to object words, but only some were told to point at the named objects. Before each training session and at follow-up, children interacted naturally with their parents to establish a baseline against which changes in communication were measured. Children who were told to gesture increased the number of gesture meanings they conveyed not only when interacting with the experimenter during training, but also when later interacting with their parents. Critically, these experimentally-induced increases in gesture led to larger spoken repertoires at follow-up. The findings suggest that gesturing can play an active role in word learning, perhaps because gesturing to a target picture in the context of labeling focuses children's attention to objects in the environment, to the labels, or to the object-label relation (Goldfield & Reznick, 1990; Werner & Kaplan, 1963). Children's active engagement in the bidirectional labeling context when told to gesture may draw their attention to gesture's communicative function, which could also have beneficial consequences for vocabulary development (Csibra & Gergely, 2009;

Tomasello, Carpenter, & Liszkowski, 2007; Woodward & Guajardo, 2002; Yoon, Johnson, & Csibra, 2008).

Although we know that encouraging children to point at objects enhances word learning, there have been no studies to date encouraging children to produce supplementary gesture + speech combinations. We thus know only that early supplementary gesture + speech combinations reflect the child's readiness to produce two-word utterances. More work is needed to determine whether these combinations play an active role in bringing about the onset of two-word utterances.

Gesture elicits timely speech from listeners

The second way in which child gesture could play a role in language learning is more indirect—child gesture could elicit timely speech from listeners (see, for example, Kishimoto, Shizawa, Yasuda, Hinobayashi, & Minami, 2007). Because gesture seems to reflect a child's readiness for acquiring a particular linguistic structure, it has the potential to alert listeners (parents, teachers, clinicians) to the fact that a child is ready to learn that word or sentence. Listeners who pay attention to those gestures and can “read” them, might then adjust their talk, providing just the right input to help the child learn the word or sentence. Consider a child who does not yet know the word “rabbit” and refers to the animal by pointing at it. His obliging mother responds, “yes, that's a rabbit,” thus supplying him with just the word he is looking for. Or consider a child who points at her mother while saying the word “hat.” Her mother replies, “that's mommy's hat,” thus translating the child's gesture + word combination into a simple sentence.

Just as mothers are sensitive to whether their children are familiar with the words they present, adjusting their strategies to make the word comprehensible (e.g., linking the new word to related words, offering terms that contrast with it directly, situating it by appealing to past experiences, Clark, 2010), mothers are sensitive to their children's gestures (Golinkoff, 1986; Masur, 1982). Mothers translate into their own words not only the single gestures that children produce (e.g., “that's a bird,” produced in response to the child's point at a bird), but also the gestures that children produce in combination with words conveying different information, that is, supplementary gesture + speech combinations (“the bird's taking a nap,” produced in response to the child's point at bird + “nap”) (Goldin-Meadow, Goodrich, Sauer & Iverson, 2007). Interestingly, mothers produce longer sentences in response to their children's supplementary gesture + speech combinations (point at bird + “nap”) than to their complementary gesture + speech combinations (point at bird + “bird”). Moreover, mothers' sentences tend to be longest when they pick up on information conveyed in child speech *and* gesture (e.g., “the *bird's* taking a *nap*”), despite the fact that they could easily have produced sentences

that are just as long when they pick up on information conveyed only in the child's speech ("It's time for your *nap*") or only in the child's gesture ("It's just like grand-ma's *bird*") or when they ignore the child's utterance entirely ("Let's read another book") (Goldin-Meadow et al., 2007).

If child gesture is playing an instrumental role in language learning, mothers' translations ought to be related to later word- and sentence-learning in their children--and they are (Goldin-Meadow et al., 2007). In terms of word-learning, when mothers translate the gestures that their children produce into words, those words are more likely to quickly become part of the child's vocabulary than words for gestures that mothers do not translate. In terms of sentence-learning, children whose mothers frequently translate their child's gestures into speech tend to be first to produce two-word utterances. The age at which children produce their first two-word utterance is highly correlated with the proportion of times mothers translate their child's gestures into speech, suggesting that mothers' targeted responses to their children's gestures might be playing a role in helping the children take their first steps into multiword combinations. Because they are finely-tuned to a child's current state (cf. Vygotsky's, 1986, zone of proximal development), adult responses of this sort could be particularly effective in teaching children how an idea is expressed in the language they are learning.

Gesture as a diagnostic tool for language delay

Children with early right hemisphere lesions have been found to display delays in gesture early in development (Bates et al., 1997; Marchman et al., 1991). Are the children who exhibit delays in gesture the same children who exhibit delays in vocabulary development? We might expect delays in gesture use to go hand-in-hand with delays in language simply because, as we have seen here, gesture and language form an integrated system in typically developing children at the early stages of language learning. If the gesture-language system is robust in the face of early unilateral brain injury, children whose language development is proceeding at a typical pace should display typical gesture, and children whose language is delayed should display delays in gesture. Moreover, early gesture should predict subsequent language development, as it does in typically developing children. If this is the case, child gesture has the potential to serve as an early diagnostic tool, identifying which children will exhibit subsequent language delays, and which will catch up and thus fall within the normative range.

Children with pre- or perinatal unilateral brain lesions (PL) exhibit marked plasticity for language functions. Even when their lesions affect classic language areas, children with PL typically do not exhibit the aphasias that adults with similar

lesions display (e.g., Bates & Dick, 2002; Feldman, 2005). However, children with PL often exhibit delays in both productive and receptive language and these delays are transient for some children with PL, but persistent for others (Bates, Thal, & Janowsky, 1992; Feldman, Holland, Kemp, & Janosky, 1992). Can early child gesture be used to predict subsequent vocabulary development in children with PL?

Sauer, Levine and Goldin-Meadow (2010) categorized 11 children with PL into two groups based on whether their gesture use at 18 months was within or below the range for typically developing (data from 53 children were used to establish the range): (1) Children in the LOW group ($n = 5$) fell below the 25th percentile for gesture production at 18 months in the typically developing group. (2) Children in the HIGH group ($n = 6$) fell above the 25th percentile. Sauer and colleagues also charted the number of different words that the children with PL produced, again in relation to the number produced by the typically developing children. As a group, the children with PL produced more and more different words over time. However, there was a great deal of variability within the group. The question is whether this variability can be related to gesture use at 18 months.

Children with PL whose gesture use was within the range for typically developing children at 18 months, the HIGH group, developed a productive vocabulary at 22 and 26 months that was within the normative range, indeed close to the mean. In contrast, children with PL whose gesture use was below the range for the typically developing children at 18 months, the LOW group, remained outside of (and below) the normative range at both 22 and 26 months. The children displayed a similar pattern for receptive vocabulary (PPVT administered at 30 months). There was a significant correlation between the number of gesture types a child produced at 18 months and that child's PPVT score at 30 months. Importantly, speech at 18 months could not be used to predict children's later PPVT scores simply because there was very little variation in the number of speech types the PL children produced at 18 months—all of the children produced very few. These findings suggest that early gesture can predict subsequent spoken vocabulary, both productive and receptive, not only for children who are learning language at a typical pace, but also for those who are exhibiting delays.

Özçalışkan, Levine, and Goldin-Meadow (2013) found similar effects with respect to the onset of different types of sentence constructions in 11 children with PL, compared to 30 typically developing children. On average, children with PL produced their first instance of a two-argument sentence in gesture + speech (“mama” + point at stairs) four months later than the typically developing children, and the children with PL were comparably delayed in their first instance of a two-argument sentence conveyed entirely in speech (“turtle in truck”). The children with PL displayed the same pattern for argument + predicate sentences, producing them first in gesture + speech (“drink” + point at juice) and only later

entirely in speech (“pour the tea”), both at a 4-month delay relative to the typically developing children. However, the children with PL (unlike the typically developing children) did not reliably produce predicate + predicate constructions in gesture + speech (“I see” + GIVE gesture) before producing them entirely in speech (“I get zipper and zip this up”). Overall, the gesture-speech system appears to be a robust feature of language learning for simple – but not complex – sentence constructions, acting as a harbinger of change in language development even when that language is developing in an injured brain.

The paucity of particular gesture constructions in children with PL has the potential not only to serve as a diagnostic for later language delay, but also to contribute to those delays. First, the fewer gestures that children with PL produce, the fewer opportunities they have to practice communicating ideas they cannot yet express in speech. Second, the relatively small number of single gestures and gesture + speech combinations that children with PL produce provides parents with fewer opportunities to “translate” gesture into words, and thus fewer opportunities to tailor their input to what’s currently on the child’s mind. A good strategy for interacting with children with PL (and even typically developing children) is to encourage them to gesture as they talk. Augmenting child gesture will increase opportunities for child practice and for parents to fine-tune their input to the child’s state. Moreover, encouraging children to gesture has the potential to bring out previously unspoken ideas—once in the child’s production repertoire, those ideas can take hold and facilitate learning (cf. Broaders et al., 2007).

Conclusion

We know that children come to language learning with ideas about how communication ought to be structured—for example, deaf children who are not exposed to a usable model of a conventional language nevertheless invent communication systems that have many of the fundamental properties of natural language (Goldin-Meadow, 2003; 2005). The challenge for children who *are* exposed to a conventional language is to mesh the ideas they bring to language learning with the details of the particular language that they are actually learning. It is here where gesture can play a seminal role. Child gesture gives children the opportunity to practice expressing ideas in a preverbal form, ideas that are packaged in words or in sentences. Equally important, child gesture gives parents the opportunity to (literally) see ideas that the child is on the cusp of expressing in speech—parents can, for example, see when their child is ready to acquire sentences by watching the child’s hands while listening to her words. By translating the gestures children produce into speech, parents can provide linguistic input that is tailored to the child’s state,

thus taking advantage of a “teachable” moment. In the tradition of Eve Clark’s research, gesture thus provides another example of how language is learned in the details of interaction (cf. Clark & Amaral, 2010).

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