

Guides to Research Methods in Language and Linguistics

Series Editor: Li Wei, Birkbeck College, University of London

The science of language encompasses a truly interdisciplinary field of research, with a wide range of focuses, approaches, and objectives. While linguistics has its own traditional approaches, a variety of other intellectual disciplines have contributed methodological perspectives that enrich the field as a whole. As a result, linguistics now draws on state-of-the-art work from such fields as psychology, computer science, biology, neuroscience and cognitive science, sociology, music, philosophy, and anthropology.

The interdisciplinary nature of the field presents both challenges and opportunities to students who must understand a variety of evolving research skills and methods. The *Guides to Research Methods in Language and Linguistics* address these skills in a systematic way for advanced students and beginning researchers in language science. The books in this series focus especially on the relationships between theory, methods and data – the understanding of which is fundamental to the successful completion of research projects and the advancement of knowledge.

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Research Methods in Child Language

A Practical Guide

Edited by Erika Hoff

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Editorial Offices
350 Main Street, Malden, MA 02148-5020, USA
9600 Garsington Road, Oxford, OX4 2DQ, UK
The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

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14 Studying Gesture

*Erica A. Cartmill, Özlem Ece Demir,
and Susan Goldin-Meadow*

Summary

To gain a full understanding of the steps children follow in acquiring language, researchers must pay attention to their hands as well as their mouths – that is, to gesture. We first define our methodology for studying gesture. We then describe different types of gestures and their typical uses, and the methods by which meaning can be attributed to gesture. We stress the importance of characterizing the relationship between gesture and speech, and illustrate how that relationship changes over time as children’s spoken language develops. Importantly, the methods for coding and analyzing gesture in relation to speech also change over time, and we provide examples of these changes. We end by discussing gesture’s role in language learning and later stages of cognitive development.

Introduction

The spontaneous gestures that speakers produce when they talk constitute a rich and multifaceted phenomenon, one that has generated a field of research dedicated solely to its study (e.g., McNeill, 1992). The term “gesture” has been used to describe a variety of body and facial movements, both rehearsed and spontaneous. Studies of gesture are wide-ranging and focus on, for example, gesture’s role in language production and comprehension (Albali, Kita, and Young, 2000; Goldin-Meadow, 1999), including its neural correlates (Kelly, Kravitz, and Hopkins, 2004) and how it varies across languages (Kita and Ozütrek, 2003); gesture’s role in teaching and learning (Goldin-Meadow and Wagner, 2005); and gesture when it takes over as the primary mode of communication in children who do not have a conventional language

(Goldin-Meadow, 2003; 2009) and in adults who do (Goldin-Meadow *et al.*, 2008). We focus here on the spontaneous gestures that children produce when communicating with others. Recent work suggests that this type of gesture plays a role in language development, and that important insights can be gained about language learning by examining not only what children say with their words, but also what they say with their gestures. This chapter outlines a general framework for studying gesture in relation to language learning. We first provide guidelines for identifying and categorizing gestures at different stages of language development. We then give a brief description of insights already gained from including gesture in the study of language development. We conclude with a picture of where the field may take us in the future.

Gesture is an integral part of children’s communicative repertoires. Before they are able to produce any words at all, children use gesture to communicate (Bates, 1976). Gesture thus provides a window onto the meanings and concepts that children at the earliest stages of language learning are not yet able to convey in speech. Moreover, children eventually grow not only into adult speakers but also into adult gesturers, and the period between children’s first gestures and their acquisition of a fully fluent language presents a rich and changing landscape of communicative development. It is in this landscape that gesture plays its most significant role by supplementing, predicting, and perhaps even facilitating the development of spoken language. Using gesture as a variable in studies of language learning, researchers are able to ask more targeted questions about predictors of vocabulary, syntax, and narrative development. We suggest that it is only by examining speech and gesture together that language acquisition researchers can gain a full understanding of a child’s communicative intentions and abilities.

Gesture can be studied in children of all backgrounds, all ages, and all abilities. Comparing gestures used during language acquisition across speakers of different languages not only reveals similarities in the way gesture accompanies and adds to speech across languages, but can also reveal which aspects of gesture are shaped by the language-specific constraints of the accompanying speech (So, Demir, and Goldin-Meadow, 2010). Comparing gestures across age groups is useful in revealing the changing roles of speech and gesture during the acquisition of spoken language. Comparing gestures across children whose language trajectory is likely to be atypical (e.g., children with autism, Down syndrome, or early brain injury) is useful in understanding the nature of the child’s delay. Moreover, gesture has been shown to be an early indicator of language delay (Iverson, Longobardi, and Caselli, 2003; Sauter, Levine, and Goldin-Meadow, 2010; Thal and Tobias, 1992), raising the possibility that gesture can be used for early diagnosis and intervention when language learning goes awry (LeBarton and Goldin-Meadow, under review).

Methods

The first step in including gesture in a study of language acquisition is to isolate gesture from the ongoing stream of motor behavior. We define gesture as a movement that is *part of an intentional communicative act* but is not a functional act in the real world

(Goldin-Meadow and Mylander, 1984). For example, actively trying to twist the lid of a jar while looking at mother, although part of a communicative act, is a direct manipulation of an object and therefore not a gesture. In contrast, producing a twist-like movement removed from the jar while eyeing mother would constitute a gesture. Once isolated, gestures must be characterized in terms of their form and meaning.

Gesture Form

Gestures can be described in terms of the three parameters typically used to code conventional sign languages: (1) the shape of the hand, (2) the movement of the hand, and (3) the location of the hand in space. In principle, several gestures can be concatenated into a single string; if the hands do not relax and there is no pause between the gestures, the gestures constitute a string. However, in reality, typically developing hearing children rarely concatenate gestures into strings (Goldin-Meadow and Mylander, 1984).

Gestures are often classified on the basis of their form and function into one of the following four categories (McNeill, 1992). All of these gesture types convey some aspect of meaning and, in this sense, are distinct from manual movements that serve as self-adaptors (e.g., scratching or adjusting clothing; Ekman and Friesen, 1969) or that are associated with speech failures (Butterworth and Hadar, 1989).

- 1 *Deictic* gestures direct attention toward a particular object, person, or location in the surrounding environment (Figure 14.1A). Deictics are typically produced with an index finger point, but any part of the body may be used and, indeed, some cultures point predominantly with the whole hand or by inclining the head (Wilkins, 2003).
- 2 *Conventional* gestures have an agreed meaning and form within a given community and are therefore culturally shared symbols. They can be arbitrary in form (e.g., the OKAY or THUMBS-UP gestures) or ritualized from a frequent action (e.g., infants' PICK-ME-UP arm raise) (Figure 14.1B).
- 3 *Representational (iconic and metaphoric)* gestures reference objects, actions, or relations by recreating an aspect of their referent's shape or movement. Iconic gestures represent physical objects or events (Figure 14.1C). Metaphoric gestures represent abstract ideas or concepts (e.g., moving the hands forward when talking about the future).
- 4 *Beat* gestures are movements (typically of the hands or head) that correspond to and highlight the prosody of the accompanying speech. Beats do not have an easily discernible semantic meaning, but typically reflect the speaker's understanding of narrative or discourse structure (Figure 14.1D).

It is important to note that a single gesture may have deictic, representational, and discourse-marking beat elements. Take, for example, a gesture produced while saying, "You need to put them in order." The speaker extends her open, flat hand towards a messy bookshelf, with the palm turned sideways (in the orientation of a book), and makes three chopping downward motions while moving her hand to the



Figure 14.1 Examples of gestures produced by children in the early stages of language learning. (A) Point gesture: an 18-month-old child points at a marker without talking. (B) Conventional gesture: a 46-month-old child produces a conventional STOP gesture while saying "stop." (C) Iconic gesture: a 46-month-old child moves his hand across the table wiggling his fingers while saying "he crawled over." (D) Beat gesture: a 46-month-old child says "milk and brown sugar" and beats his hand downwards on "brown" and "sugar" side; each chop is produced with a different word ("put," "them," "in order"). The gesture indicates the books (the deictic element), represents how the books should be arranged (the iconic representational element), and highlights the prosody of speech by accenting the words with which it occurs (the beat element). Given that it is often difficult to classify a gesture according to type (i.e., as solely deictic, conventional, representational, or beat), it is often more revealing to know the gesture's meaning in relation to the speech it accompanies than to merely know its type.

Gesture Meaning

The meaning assigned to a gesture is derived not only from its form, but also from the physical environment and linguistic context within which it is produced. However, the relative importance of form, environment, and context in determining a gesture's meaning differs across gesture types. The meaning of a deictic gesture is determined by the object, person, or place toward which it is directed (e.g., a point at a dog is taken

to mean *dog*) and is thus heavily dependent on its physical environment. The meaning of a conventional gesture is determined by the culture within which it is used (e.g., the THUMBS-UP gesture means *things are good* in American culture). The meaning of a representational gesture is determined by its form in relation to its linguistic and discourse context (e.g., a hand rotating in the air might mean *twirl* when describing a ballerina dancing, or *twist open* when requesting mom to open a bubble jar).

Importantly, the role that gesture plays in relation to speech changes over the course of language acquisition. In adult speakers, gesture is produced in the context of speech more than 90% of the time (McNeill, 1992). At the earliest stages of language learning, infants use gesture on its own, although even these early gestures are usually accompanied by meaningless vocalizations (Iverson and Theilen, 1999). Interestingly, at the same time that children begin to produce meaningful words along with their gestures, they also begin to synchronize their vocalizations (both meaningful and meaningless) with those gestures (Butcher and Goldin-Meadow, 2000), thus integrating gesture with speech semantically and temporally.

Once gesture begins to be routinely produced with speech, communicative acts can be examined from the perspective of both gesture and speech. A communicative act is defined as a string of words or gestures that is preceded and followed by a pause, a change in conversational turn, or a change in intonational pattern. Communicative acts can be classified into three categories. (1) *Gesture-only* acts are gestures produced without speech, either singly (e.g., point at cookie) or, much less frequently, in combination (e.g., point at cookie + point at mother). (2) *Speech-only* acts are words produced without gestures either singly (e.g., "cookie") or in combination ("mommy cookie," "baby drink juice"). (3) *Gesture-speech combinations* are acts containing both gesture and speech (e.g., "nice doggie" + point at dog; "mommy" + point at cookie).

For gesture-speech combinations, the meaning gesture conveys must be interpreted in relation to the meaning conveyed in the accompanying speech. Gesture often conveys information that is, for the most part, redundant with speech ("ball" + point at ball). But gesture can also convey information that is different from the information conveyed in the accompanying speech ("ball" + point at the location where the ball belongs, used to mean *ball goes there*). One of the best ways to determine whether a gesture is conveying information that goes beyond the information found in the accompanying speech is to turn off the video component of the tape and listen to the speech without gesture. In this case, all we would hear is "ball," suggesting that the sentence-like *ball goes there* meaning comes from integrating information from the two modalities.

Gesture's Changing Role over Language Development

Gesture is sensitive to a child's developmental stage. The types of meanings conveyed in gesture, and the information gesture adds to speech, change over development as the child's speech skills develop. We therefore need to take the child's level of language

development into account when analyzing gesture. Here we outline the early periods in language development. For each period, we discuss how gesture's role changes as speech becomes more adult-like, and how the approach to gesture analysis must also change as a result. We also describe the information gesture typically adds to speech, and the changes gesture signals with respect to future language development.

Pre-linguistic Period (Approximately 6–10 Months)

Characteristics

This stage is characterized by a dominance of gesture over speech. Infants have few, if any, words during this period and communicate primarily through gesture – typically pointing gestures, hold-up gestures in which an object is held up and displayed to another, or palm extended GIVE gestures (Bates, 1976). Although not accompanied by words, gestures at this stage often co-occur with meaningless vocalizations (Iverson and Theilen, 1999). At this age, infants in the US are often taught to communicate using "baby signs" (Acredolo, Goodwyn, and Abrams, 2002); if possible, when transcribing a child's gestures, it is a good idea to distinguish learned baby signs from naturally occurring gestures.

Coding and analyses

During this early period, the most interesting aspect of gesture is the nature and diversity of the meanings it conveys. Assigning meaning to gesture during the pre-linguistic period involves paying attention to the physical environment in which the gesture is produced, the ongoing social interaction, and the linguistic discourse context provided by parents and other communication partners. The number of different meanings children convey in gesture at this stage of language development (e.g., the number of different types of objects a child points to) has been found to predict the size of the child's vocabulary later in development (Rowe and Goldin-Meadow, 2009a). The number of meanings conveyed in gesture can also be used to distinguish children with brain injury who are likely to continue to be delayed with respect to word learning from those who are able to acquire words at a typical rate (Sauer, Levine, and Goldin-Meadow, 2010). In studies of this sort, the number of gesture meanings early in development is correlated with the number of different words the child produces (as measured by word types in spontaneous speech) or understands (as measured by the Peabody Picture Vocabulary Test, PPVT: Dunn and Dunn, 1997) at a later time point.

When assigning meaning to deictic gestures, the tendency is to assume that the infant is referring to a physically present object. However, Liszkowski and colleagues (2009) have shown that even very young children can point to the place where an object was in order to refer to the now-absent object (see also Butcher, Mylander, and Goldin-Meadow, 1991). Thus, it is important for researchers to allow for the possibility that early communication refers to objects and people outside the

immediate environment. Overall, pre-linguistic gesture provides a unique opportunity to assess communicative development before the onset of spoken language and to predict upcoming changes in speech.

One-Word Period (Approximately 10–24 Months)

Characteristics

In this period, children begin to build a spoken vocabulary and to communicate using one-word utterances. However, those words are often accompanied by gesture.

Coding and analyses

Once gestures are routinely accompanied by a spoken word, it is important to code the relation between the information conveyed in gesture and the information conveyed in the accompanying speech. Gesture can be used to *reinforce* the information conveyed in speech (e.g., a point to a book accompanied by the word “book”; a side-to-side head shake accompanied by “no”). Gesture can also be used to *disambiguate* the information conveyed in speech; these gestures typically co-occur with nonspecific demonstrative or pronominal forms (e.g., a point to a particular location accompanied by “there”; a point to a toy accompanied by “it”). Finally, gesture can *add* information to the information conveyed in speech (e.g., a point to ball accompanied by “want”; a palm extended in a conventional GIVE gesture accompanied by “cookie”). Keeping track of gestures that add information to speech not only provides a more complete picture of a child’s communicative skills, it also gives us a way to predict the onset of two-word speech. The age at which a child first produces combinations in which gesture and speech together convey sentence-like information (e.g., point at box + “open”) reliably predicts the age at which the child will produce her first two-word utterance (“open box”) (Goldin-Meadow and Butcher, 2003; Iverson and Goldin-Meadow, 2005).

Gestures that add information to speech can be further categorized according to the type of information they contribute. For example, gesture may add noun-like information to a spoken adjective (e.g., point to flower + “pretty”). In these gesture–speech combinations, gesture adds information about an object and, in this sense, the process is like building a noun phrase. In other gesture–speech combinations, gesture adds subject or object information to a spoken verb (e.g., point to mother + “dance”; point to bottle + “give”) or action information to a spoken noun (e.g., an iconic OPEN gesture + “box”). In these cases, the process is like building predicate structure. Identifying and classifying sentence-like gesture–speech combinations is important because their prevalence early in development can be used to predict overall syntactic complexity at later stages of language learning (Rowe and Goldin-Meadow, 2009b). More specifically, multiple regression analyses show that the number of gesture–speech combinations children produce at 18 months predicts grammatical complexity (as measured by the Index of Productive Syntax, IPSym:

Scarborough, 1990), although not vocabulary size, at 42 months. Interestingly, the number of gesture meanings produced at 18 months shows the reverse pattern: it predicts vocabulary size, but not grammatical complexity, at 42 months, demonstrating that gesture selectively predicts language learning.

Moreover, the particular constructions expressed in these gesture–speech combinations can be used to predict the emergence of the same constructions in speech later in development (Özçalışkan and Goldin-Meadow, 2005). Chi-square analyses can be used to compare the number of children who express a particular construction first in speech + gesture to those who express the construction first in speech alone. Interestingly, although children seem to rely on gesture to produce the first instance of a construction (e.g., a predicate plus one argument: “give” + point at cookie), once the construction is established in their repertoire, children are no more likely to use gesture to flesh out the construction than they are to use speech. For example, they are just as likely to produce a predicate plus three arguments entirely in speech (“you see my butterfly on my wall”) as they are to use a combination of gesture and speech (“Daddy clean all the bird poopie” + point at table) (Özçalışkan and Goldin-Meadow, 2009). Gesture thus acts as a harbinger of linguistic steps only when those steps involve new constructions, not when the steps merely flesh out existing constructions.

Later Language Development and Early Discourse (Starting at Approximately 24 Months)

Characteristics

During this period, children acquire many different linguistic features: they speak in multi-word utterances; acquire prepositions, determiners, demonstratives; conjugate verbs; and begin to use multi-clausal utterances. Children also increase their use of iconic gestures (Özçalışkan and Goldin-Meadow, in press) and begin to produce discourse-marking gestures such as beats (McNeill, 1992).

Coding and analyses

As children’s speech increases in complexity, and as they produce more iconic representational gestures, the relationship between gesture and speech becomes more complex. Representational gestures can convey many different aspects of an object, event, or idea simultaneously, and thus can have multiple relationships to the surrounding speech. For example, a child might accompany the utterance “put it on top” with a gesture in which a curved hand is lowered onto an imaginary surface as if setting down a glass. In this case, the action and path of movement are *reinforced* by the gesture, but the characteristics of the moved object are conveyed only in gesture and are thus *added* by gesture. Coding the particular information that is either reinforced or added by gesture becomes particularly important as iconic gestures become more frequent in a child’s repertoire and metaphorical gestures begin to emerge.

As in earlier periods of language development, gesture is used to express more complex structures than children express in speech alone. The range of information gesture adds to speech increases with children's communicative complexity. For example, where gesture would add an argument or a predicate to a single-word utterance in the one-word stage, it can now add a new predicate to a single clause while producing an iconic EAT gesture, in effect conveying two predicates. Or the child says, "me try it," while producing a conventional GIVE gesture.

Thus, the information conveyed in gesture needs to be coded for the semantic relation it holds to the information conveyed in the accompanying speech. These gesture-speech relationships grow more complex and subtle as speech becomes more proficient. For example, when children begin to express causal relationships in speech (e.g., "he broke the window"), they use gesture to convey information about agents, patients, or instruments. Three-year-olds use gesture primarily to reinforce the goal of an action, but 5-year-olds use gesture to add information about the instrument or direction – information that is often not found in the accompanying speech (e.g., producing an iconic THROW gesture that adds information about the instrument to the utterance "he broke the window"; Gökşun, Hirsh-Pasek, and Golinkoff, 2010). As another example, when children begin to describe motion events in speech (e.g., "it went under there"), gesture is often used to reinforce or add information about manner, path, source, and endpoint. The type of information children choose to convey in gesture reflects not only their understanding of the event, but also the linguistic framing of the language they are learning (Özyürek *et al.*, 2005; Özyürek and Özçalışkan, 2000). Crosslinguistic studies of gesture's relation to speech can thus provide insight into how children come to describe events in the manner typical of their language.

In addition, as children begin to engage in extended discourse with others, the relationship between children's gestures and the ongoing social context can become a window onto their understanding of shared reference. When children introduce into the conversation a referent not previously known to their conversation partner, they often produce a gesture along with their speech, thus marking the referent as new. For example, children are more likely to point at a toy if the toy has not been mentioned earlier in the conversation than if it has been mentioned (So, Demir, and Goldin-Meadow, 2010).

Narrative Development (Starting at Approximately 4 Years)

Characteristics

As children become more comfortable with the basic aspects of language such as vocabulary and syntax, they start to engage in larger stretches of discourse. When producing extended discourse structures, children are required for the first time to pay attention to the macro-level structure of these larger units. The way in which gesture relates to speech changes during these later stages as gesture begins to add metalinguistic information (e.g., gestures highlight events that form the plotline of a

narrative). With the emergence of discourse skills, children's gestures begin to structure the accompanying speech, mirroring the gesture-speech relation observed in adults.

Coding and analyses

During this period, gesture can be studied in relation to how it helps construct or support narrative structure. For example, children's iconic gestures reveal information about the perspective they take *vis-à-vis* the event they are describing. Iconic gestures can be produced from two different perspectives: character viewpoint and observer viewpoint. In character viewpoint gestures, the gesture portrays an event from the character's point of view (e.g., pumping the arms as though running to describe a character who is moving quickly; moving a closed hand away from the torso to describe a character giving something away). In observer viewpoint gestures, the gesture portrays the event from the observer's point of view (e.g., moving the two fingers of an upside-down V-hand back and forth, representing the moving legs of a character in a running event; or moving an index finger up to represent the ascent of the character in a climbing event).

The viewpoint of a child's gestures reveals if and when the child is able to take the perspective of different characters in a story. At initial stages of narrative development, being able to produce character viewpoint gestures is associated with better developed narrative skills in speech at that moment and in the future (Demir, 2009). Multiple regression analyses reveal that producing character viewpoint gestures when retelling a cartoon story at age 5 predicts narrative complexity (as measured by number of plotline events mentioned), and overall story structure) at age 6. How children use character vs observer viewpoint gestures also reveals their understanding of the central events in a narrative. Character viewpoint gestures tend to accompany events that are central to narrative structure (e.g., the main goal of the protagonist); observer viewpoint gestures tend to accompany events that are more peripheral to the main plotline (McNeill, 1992). Being able to use character viewpoint gestures for important events emerges around 6 years of age, and is associated with narratives that are better structured (i.e., children who use character viewpoint gestures to highlight important events produce stories with significantly higher complexity scores than children who do not use these gestures; Demir, 2009).

As a second example of how gesture can be used to structure discourse, recurring gestural features (hand configuration, location, and orientation) can be used to refer back to a character and, in this way, enhance the cohesion of a narrative (McNeill, 1992). As their narrative skills develop, children begin to use the shape and placement of the hand to keep track of characters. For example, in describing a cartoon, a child consistently uses a gesture shaped like a beak produced in front of his torso to refer to a bird. This gesture is used exclusively for the bird throughout the narrative and thus serves to mark the bird as a recurring character in the story. Narrative cohesion can also be enhanced by the use of space. In telling a narrative, adults produce a gesture for a character in a particular location and then gesture toward this location whenever they refer back to the character (So, Demir, and Goldin-Meadow, 2005).

Children do not appear to use gesture space systematically to refer back to previously introduced characters in their early narratives, and we do not yet know when children first begin to use this gestural device to enhance the cohesion of their narratives. Beat gestures also play an important role in adult narrative production. Adults use beats when they suspend talking about the narrative plotline to make a metanarrative comment or repair lexical items (McNeill, 1992). Beats thus serve to mark events as on or off the narrative line. Children occasionally use beats for emphasis around age 5, but the age at which beats take on a functional metalinguistic role in narrative is currently unknown.

Summary of Gesture's Changing Role over Language Development

When adding gesture to a language learning study, researchers must carefully consider the child's stage of language development, simply because gesture starts to take on new roles as speech becomes the preferred modality of communication. In pre-linguistic children, gesture assumes the primary burden of communication, but, as children pass through the one-word stage, gesture is combined with speech and, as such, often forms sentence-like utterances. During this period, gesture can be used to elaborate noun phrases or to construct single- or multi-clausal utterances. When children begin to use narrative, gesture helps to structure language on the macro level, and researchers must then consider the role that gesture is playing in relation to the overall discourse structure. Table 14.1 illustrates how gesture can play different roles at different points in development, and what types of questions researchers can ask about gesture at each of these points.

Gesture as a Potential Mechanism of Language Learning

Thus far we have been discussing how gesture can be studied in relation to children's speech as a way to gain insight into the cognitive and communicative processes that underlie language learning. However, the fact that child gesture correlates with, and predicts, subsequent language learning suggests that gesturing may be playing a role in *facilitating* language development, not just *reflecting* it. To explore this possibility, we must move beyond naturalistic data and experimentally manipulate gesture, as has been done in older children learning mathematical concepts (e.g., Broaders *et al.*, 2007; Goldin-Meadow, Cook, and Mitchell, 2009). In these cases, gesturing brings about learning by altering the child's cognition.

Child gesture can also play a role in language learning by altering the child's communicative situation; in particular, by eliciting from communication partners a linguistic input that is targeted to the child's needs at the moment. For example, a child points at an unknown object and her mother provides the label for the object,

"that's a giraffe"; the child is hearing the label at a moment when her attention is focused on the object and may therefore be particularly ready to learn the label. Or a child may say "nap" while pointing at a sleeping bird, and mother responds with the sentence, "yes, the bird is napping," thus providing a way to translate the child's gesture-speech combination into an English sentence (Goldin-Meadow *et al.*, 2007). The responses children receive to their own gestures may thus help them acquire linguistic constructions.

In addition, adult gesture, and specifically, the gestural input that children receive from either their parents or their teachers, may also play a role in language learning. Others' gestures might draw a child's attention to particular objects, making the child more likely to learn the labels for those objects. Or the gestures others produce might help the child acquire vague or abstract language by relating abstract speech to the physical environment. Past work has found that parents who use gesture to communicate a greater range of meanings have children who subsequently develop larger vocabularies (Rowe and Goldin-Meadow, 2009b). In addition, the gestures that others produce along with specific types of language have been found to facilitate a child's acquisition of that language. For example, parent gesture that is produced along with spatial language predicts children's subsequent spatial language development (Cartmill *et al.*, 2010).

Gesture thus has the potential to play a role in a child's language development when it is produced or observed by the child, and when it is produced or observed by a parent or other communication partner.

Gesture's Changing Role in Cognition

An important question for future work is whether gesture's role in communication and cognition changes over time and, if so, when the change occurs. Proficient language users, like beginning language learners, convey information in gesture that is different from the information conveyed in speech and often do so when describing tasks that they are on the verge of learning (Goldin-Meadow, 2003). As we have described here, the learning task facing the young child is language itself. When gesture is used in these early stages, it is used as an assist into the linguistic system, substituting for words that the child has not yet acquired. But once the basics of language have been mastered, children are free to use gesture for other purposes – in particular, to help them grapple with new ideas in other cognitive domains, ideas that are often not easily translated into a single lexical item.

As a result, although gesture conveys ideas that do not fit into speech throughout development, we might expect to see a transition in the kinds of ideas that gesture conveys once children have become proficient language users. Initially, as seen in many of the examples described here, children often use gesture as a substitute for the words they cannot yet express. Later, once they have mastered language and other learning tasks present themselves, they begin to use gesture in more adult ways, expressing in their gestures ideas that do not fit neatly into word-like units. From a

Table 14.1 Examples of gesture coding at different stages of language development

Period	Utterance	Gesture	Gesture's relationship to speech	Interpretation of gesture meaning	Possible research question
Pre-linguistic	" <u>Da!</u> "	Point to bear	No meaningful speech	Bear	Does the range of objects indicated by deictic gesture relate to future vocabulary acquisition?
One-word stage	" <u>Pretty</u> "	Point to flower	Adds argument	Gesture adds an argument to speech thus building a noun phrase (<i>pretty flower</i>)	Do children convey noun phrases in speech plus gesture before conveying them in speech alone?
	" <u>You</u> "	Iconic HIT gesture (open hand sweeps downwards quickly)	Adds predicate	Gesture adds a predicate to speech thus building a simple sentence (<i>you hit</i>)	Do children convey sentential relations in speech plus gesture before conveying them in speech alone?
Later language development	"It went <u>under there</u> "	Point to chair	Disambiguates argument	Gesture disambiguates the referent of the deictic "there"	Does gesture precede and predict talk about spatial relationships?
Narrative development	" <u>You gotta see them</u> "	Iconic SPREAD gesture (spread both hands apart over surface of table)	Adds predicate	Gesture adds a predicate to speech, creating a multi-clausal sentence (<i>you gotta spread them out so you can see them</i>)	Do children use gestures to create multi-clausal utterances?
	" <u>She</u> talked to <u>her</u> "	One point to the right side of the gesture space and another point to the left side of the gesture space	Disambiguates referent	Gesture refers to a location previously associated with a referent and thus disambiguates it	Do children use gesture to disambiguate referents in speech and to provide cohesion to their narratives?
	"The mouse <u>gave a cracker</u> to the bird"	Iconic GIVE gesture (move closed hand away from the torso)	Adds perspective information	Gesture depicts act of giving from the character's perspective	Do individual differences in the perspective of children's gestures relate to narrative outcomes in their speech?

Note: Each example is accompanied by a hypothetical research question. The underlining in the utterance column reflects the fact that the gesture was produced simultaneously with the speech, and indicates where in the speech stream the gesture occurred.

methodological point of view, the important point is that coding systems for each new task need to be designed with that task in mind. Although the guidelines we have provided for describing gesture *form* can be usefully applied to any task, when the goal is to assign *meaning* to gesture we need to construct categories that are appropriate to the task at hand. For example, coding the meaning of gestures in a mathematical equivalence task is done in terms of problem-solving strategies (Broaders *et al.*, 2007; Goldin-Meadow, Cook, and Mitchell, 2009) rather than the word-like and sentence-like units we have described here for language learning.

Pitfalls

Gesture can provide insight into many different types of information (communicative intent, semantic structure, discourse, etc.), but the interpretation of the gesture depends on the developmental stage of the children studied and, to some extent, on the research question asked. This flexibility means that each study will require a coding system that is tailored to the particular question and population under study. Thus, the first step in any study involving gesture is to devise a coding system that captures information relevant to the question. In addition, because coding relies on human judgment and observation, it is important to establish inter-observer reliability between coders. The final step is, of course, to code the data, which is typically done from videotapes because gesture coding is usually too detailed to be performed in real time.

Gesture coding is a time-consuming process. Each step of the process – developing a coding system, training coders to use the system, establishing reliability between coders, and finally coding the data – takes time. The result, however, is a look into the mind of the language learning child that is often importantly different from the view provided by speech alone.

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Key Terms

Beat gesture Movement (typically of the hands or head) that corresponds to and highlights the prosody of the accompanying speech.

Conventional gesture Culturally shared symbol with a stable form and meaning used within a community.

Deictic gesture Used to direct attention toward a particular object, person, or location in the surrounding environment; typically produced with an index finger point, but may involve any part of the body or holding up an object.

Gesture–speech relationship The relationship between a gesture's meaning and the meaning of the speech it accompanies; gesture can reinforce, disambiguate, or add information to the meaning conveyed in speech.

Iconic representational gesture Represents a physical object or event by recreating an aspect of the referent's shape or movement.

Linguistic context The spoken context in which a gesture is produced, and may include the word, utterance, or discourse.

Metaphoric representational gesture Represents an abstract idea or concept by adding an iconic element to abstract ideas conveyed in speech.

Narrative cohesion The linguistic, local, micro-level relations that tie the span of idea units in the narrative together and create a text; cohesive devices include inter-clausal conjunction and pronominal reference.

Perspective The perspective from which iconic gestures are produced: first-person or “character viewpoint” gestures are made from the perspective of the gesturer; third-person or “observer viewpoint” gestures are made as if the gesturer is describing a scene from the outside.

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