# THE RELATION BETWEEN GESTURE AND SPEECH IN CONGENITALLY BLIND AND SIGHTED LANGUAGE-LEARNERS

Jana M. Iverson, Heather L. Tencer, Jill Lany,
and Susan Goldin-Meadow

*ABSTRACT:* Gesture is widely regarded to play an important role in communication, both in conjunction with and independent of speech. Indeed, gesture is known to develop even before the onset of spoken words. However, little is known about the communicative conditions under which gesture emerges. The aim of this study was to explore the role of vision in early gesturing. We examined gesture development in 5 congenitally blind and 5 sighted toddlers videotaped longitudinally between the ages of 14 and 28 months in their homes while engaging in free play with a parent or experimenter. All of the blind children were found to produce at least some gestures during the one-word stage of language development. However, gesture production was relatively low among the blind children relative to their sighted peers. Moreover, although blind and sighted children produced the same overall set of gesture types, the distribution of gesture types across categories differed. In addition, blind children used gestures primarily to communicate about objects that were nearby, while sighted children used them for nearby as well as distally located objects. These findings suggest that gesture may play different roles in the language-learning process for sighted and blind children. Nevertheless, they also make it clear that gesture is a robust phenomenon of early communicative development, emerging even in the absence of experience with a visual model.

In the early stages of language acquisition, normally developing children use both speech and gesture in their efforts to communicate. In fact,

Jana M. Iverson, University of Missouri-Columbia; Heather L. Tencer, University of Virginia; Jill Lany, University of Chicago; Susan Goldin-Meadow, University of Chicago.

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Address correspondence to Jana M. Iverson, Department of Psychology, University of Missouri-Columbia, 110 McAlester Hall, Columbia, MO 65211; e-mail: IversonJM@missouri.edu.

prelinguistic children use pointing gestures several months before they use words to refer to objects (Bates, 1976), and they continue to use gestures to support their verbal communications even after the emergence of words (Acredolo & Goodwyn, 1988; Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Goldin-Meadow, 1998; Goldin-Meadow & Morford, 1985; Iverson, Capirci, & Caselli, 1994; Morford & Goldin-Meadow, 1992).

Moreover, recent work suggests that when considered in relation to the speech it accompanies, gesture acts as a harbinger of future verbal accomplishments. For example, Goldin-Meadow and Butcher (2000) found that children who are the first to produce gesture + word "sentences" (e.g., "mommy" + point at hat) are, several months later, the first to produce two-word sentences ("mommy hat"; see also Capirci, Iverson, Pizzuto, & Volterra, 1996; Goodwyn & Acredolo, 1998). Children thus demonstrate the ability to convey propositions by combining elements across gestural and verbal modalities several months before they do so within the verbal modality alone. Moreover, the timing of these across-modality combinations predicts with some precision the onset of within-modality two-word combinations. These findings suggest that gesture taken in relation to speech reflects competence that children do not yet exhibit in speech alone, and that it may also serve as a transitional device as children acquire progressively more complex linguistic forms.

It is possible, however, that gesture is not just an index of competence but, in fact, a part of the acquisition process itself; that is, gesture may play an enabling role in language-learning. This hypothesis is difficult to explore simply because all typically developing children gesture during the early stages of language learning—an interesting fact in itself. One way that this question can be approached is to observe a group of children who, on the face of it, might be expected *not* to gesture—children who are congenitally blind and thus have never seen gesture and have no model for it. Blind children are unable to see the objects toward which an indexical gesture (a pointing gesture, for example) might be directed. Nor are they able to "catch someone's eye" in order to determine whether a gesture has been apprehended. On these grounds, children who are blind from birth might be expected to fail to gesture.

The question we ask here is whether congenitally blind children gesture during the earliest stages of language development. If not, we then ask whether the absence of gesture affects the blind child's language-learning trajectory. If so, we ask whether blind children use gesture in the same way as sighted children, and how those gestures might affect language-learning.

No studies to date have systematically examined the use of communicative gestures by very young congenitally blind children. There are, how-

ever, anecdotal reports in the literature that blind children do *not* produce any of the communicative gestures that are typically produced by prelinguistic sighted children (e.g., giving, pointing, showing, requesting; Mills, 1988). For example, Urwin (1979) noted that none of the three preverbal blind children who she followed longitudinally used gestures to draw attention to or request distant objects.

At the same time, there are indications that blind children may employ other, less conventional types of movements in their attempts to communicate. For example, Urwin (1979) noted that although her blind participants failed to point, they did make use of "sophisticated forms of body play" (p. 121) in order to attract the attention of their caregivers. More recently, Preisler (1993) found that blind children used repeated body movements to request the continuation of an activity, and that the first communicative acts produced by blind infants were expressed by body or hand/arm movements related to certain actions (e.g., bathing).

The fact that blind children use consistent movements to attract the attention of others suggests that a visual model is not essential for children to discover that the hands and body can be put to communicative use. However, these findings do not address whether blindness prevents the development of conventional hand gestures (e.g., indexical gestures). Nor do they examine how blind children's use of gesture is related to their acquisition of spoken language, or how it compares to that of sighted children of the same age.

The aim of this study is to address these issues through a systematic comparison of gesture and speech production in young congenitally blind and sighted children followed longitudinally during the second year. We examined data on blind and sighted children's production of speech and gesture, gesture types, gesture form, and objects referred to by words and gestures to address the following questions: (a) Do congenitally blind children gesture and, if so, do they use the same conventional gestures during the early stages of language development as sighted children? (b) What forms do these gestures take in young blind and sighted children? and (c) How do blind and sighted children's gestures for objects relate to their words for objects?

## Method

### *Participants*

Two seminal longitudinal studies have explored the development of language in congenitally blind children, one conducted by Andersen and

her colleagues (e.g., Andersen, Dunlea, & Kekelis, 1984, 1993; Dunlea, 1989; Dunlea & Andersen, 1992), and the other by Landau and Gleitman (1985). The findings of these studies suggest wide variability among blind children in terms of the ages at which they reach early language milestones. Our goal was to determine whether this variability was in any way related to the presence and types of gestures in the child's communicative repertoire. To do so, we recoded the videotaped data collected by Andersen and colleagues and by Landau and Gleitman, focusing on the children's gestural communication and its relation to speech.

The three blind children studied by Andersen and colleagues were second-born, full-term children from intact, monolingual English-speaking middle-class families. The male child (Teddy) is totally blind as a result of Leber's congenital amaurosis. One of the female children (Lisa) is also blind due to Leber's but has some light perception. The second female child (Lydia) is partially blind due to hypoplasia of the optic nerve of unknown etiology; she has no vision at all in her left eye, and no central vision but some peripheral form vision in her right eye. All three children appeared to be developing normally and did not have any other documented physical, mental, or emotional handicaps or neurological disorders.

Two blind children were studied by Landau and Gleitman. The male child (Carlo) is the second-born of three children and was born approximately two and a half months premature. He became blind as a result of Retinopathy of Prematurity (grade 3 in one eye and grade 4 in the other) and is considered to have light perception in the better eye. The female child (Kelli) is the first-born of two children and is the survivor of a pair of twins born approximately three months premature. She was blinded as a result of Retinopathy of Prematurity (grade 4 in one eye and grade 5 in the other) and was diagnosed as totally blind, although it was suggested in later testing that she may have some sensitivity to light in the better eye. Neither child had any other known neurological or behavioral deficits and otherwise appeared to be developing normally.

We compared the five blind children,[1] who were observed between the ages of 14 and 28 months, to five sighted children matched for sex and, as closely as possible, for age. The five sighted children were videotaped by Butcher and Goldin-Meadow (in press; Goldin-Meadow & Butcher, 2000), who describe in detail the procedures under which the observations were recorded. Information about the ages at which the blind and sighted children were videotaped is presented in Table 1.

**TABLE 1**

**Participant Information**

| Child's name | Gender | Ages observed | Number of sessions observed | Mean length of sessions | Age of first meaningful word | Age of first two-word combination |
|---|---|---|---|---|---|---|
| *Sighted Children* | | | | | | |
| Christopher | M | 12 to 23.5 mos. | 11 | 34 min. | 13.0 | 21.0 |
| Emily | F | 13.5 to 19 mos. | 9 | 30 min. | 13.5* | 18.0 |
| Nicholas | M | 15.5 to 21 mos. | 11 | 31 min. | 15.5* | 18.5 |
| Beth | F | 15.5 to 21 mos. | 5 | 50 min. | 15.5* | 18.0 |
| Ann | F | 15.5 to 25 mos. | 6 | 33 min. | 16.5 | 22.5 |
| *Blind Children* | | | | | | |
| Carlo | M | 14 to 26 mos. | 4 | 53 min. | 26.0 | 28.0–30.0 |
| Kelli | F | 22 to 28 mos. | 4 | 26 min. | 23.0 | 29.0 |
| Lisa | F | 16.5 to 20.5 mos. | 6 | 9.5 min. | 15.0** | 23.5** |
| Teddy | M | 15 to 22 mos. | 6 | 14 min. | 12.0** | 18.0** |
| Lydia | F | 16 to 22 mos. | 6 | 16 min. | 15.0** | 18.0** |

*These children produced meaningful words during their first observation sessions.
**The ages reported here for the blind children are taken from previously published reports (Dunlea, 1989; Landau & Gleitman, 1985).

*Procedure*

Because the videotaped data were collected in the course of prior research, some aspects of the observations varied both within and across groups (e.g., session length, number and types of objects present, interactive partners). In general, for both blind and sighted children, observation sessions were videotaped in the children's homes and consisted of free play with an experimenter or a caregiver. Sessions varied in length, lasting between 10 and 40 minutes (see Table 1), and occurred biweekly for three of the sighted children, and monthly for the other two sighted children and for all of the blind children. Because sessions for some of the blind children were shorter than those for the sighted children, we chose measures designed to adjust for these differences (e.g., proportions, total numbers per unit time). However, the smaller samples of behavior may have made the detection of rarely-occurring behaviors less likely.

*Coding*

We focused our analyses on gesture and speech that each child used communicatively. The criterion for coding an utterance as communicative was clear evidence of effort to direct the listener's attention (e.g., through eye gaze, vocalization, postural shift). A communicative behavior could be either a gesture on its own, speech on its own, or gesture and speech produced together.

*Coding speech.* All of the meaningful communicative vocalizations that each child produced were coded. Meaningful vocalizations were either actual English words (e.g., "dog," "cat," "duck," "hot," "walking") or speech sounds that were consistently used by a particular child to refer to a specific object or event (e.g., using "bah" to refer to a bottle).

*Coding gesture.* Several criteria were instituted to ensure that a hand movement was functioning as a communicative symbol and thus qualified as a gesture (see Goldin-Meadow & Mylander, 1984, and Butcher et al., 1991, for discussion): (a) The gesture must be directed to another individual; that is, it must be communicative. In particular, we required that the child establish eye contact, vocalize, or give other evidence of trying to attract the attention of the communication partner for the child's act to be considered a gesture. (b) The gesture must not itself be a direct manipulation of some relevant person or object (i.e., it must be empty-handed; Petitto, 1988). To be conservative, all acts that were performed on objects were excluded, with one exception—if a child held up an object to bring it

to another's attention, an act that appears to serve the same function as the pointing gesture, it was counted as a gesture. (c) The gesture must not be part of a ritual act (e.g., to blow a kiss to someone) or game (e.g., patty-cake).

All gestures were further classified into one of three categories. (a) *Deictic gestures* are gestures that indicate referents in the immediate environment and whose meanings are thus context-bound. Three types of deictic gestures were coded: (1) *showing*, or holding up an object in the listener's potential line of sight; (2) *index points*, or extensions of the index finger in the direction of a referent; and (3) *palm points*, or extensions of a flat hand, in the direction of a referent. (b) *Conventional gestures* are gestures whose form and meaning are either culturally defined (e.g., nodding the head to convey "*yes*") or specified in the context of particular caregiver-child interactions (e.g., smoothing the hands over the hair to convey "*pretty*"). (c) *Ritualized reaches* are arm extensions toward a desired object, usually accompanied by repeated opening and closing of the palm and gaze alternation between the listener and the object.

*Reliability.* Reliability between two independent coders was assessed on a subset of the videotaped sessions. For the blind children, reliability was 92% agreement between the two coders (N = 220) for isolating and identifying an utterance, 94% (N = 162) for identifying and assigning meanings to meaningful vocalizations, and 95% (N = 41) for assigning meaning to gestures. For the sighted children, agreement between the two coders was 92% (N = 142) for isolating and identifying an utterance, 96% (N = 98) for identifying and assigning meanings to meaningful vocalizations, and 96% (N = 49) for assigning meaning to gestures.

## Results and Discussion

### *Characteristics of the Children's Speech*

Table 1 presents the ages at which each child first produced a meaningful word and a two-word combination, respectively. The videotaped sessions represent a small sample of each child's communications; consequently, the onset ages listed in Table 1 may provide an overly conservative estimate of the actual ages at which these children began producing words and two-word combinations.[2] Four of the sighted children (Beth, Emily, Nicholas, and Joseph) were already producing words during their first observation sessions; the remaining two (Ann and Christopher) were not and produced their first words on the videotapes at ages 16.5 and 13

months, respectively. The ages at which the sighted children began producing two-word combinations on our videotapes ranged from 18 to 22.5 months, an age span that falls within the range typically reported for the onset of two-word speech (cf. Bloom & Capatides, 1987; Bowerman, 1973; Braine, 1976).

Of the blind children, three (Lisa, Lydia, and Teddy) were already producing words during their first observation sessions. Two children (Teddy and Lydia) began to produce two-word combinations during the course of our observations (both at 18 months), while the remaining 3 (Lisa, Kelli, and Carlo) did not and produced their first combinations at ages 28–30, 29, and 23.5 months, respectively, beyond the range of ages for which videotaped observations were available. These ages fell within the range observed among the sighted children in this study, and the ranges reported for the emergence of two-word combinations in other groups of sighted children. Thus, the blind children did not appear to exhibit particular delays in the attainment of early language milestones relative to their sighted counterparts.

### *Production of Speech and Gesture*

The left-hand panels of Figure 1 present the amount of speech produced by sighted and blind children, respectively, over developmental time. Because the length of the videotaped observations varied across children, the measure plotted is the number of word tokens (i.e., total number of words, including repetitions) produced per minute. For sighted children, speech production tended to increase in a relatively homogenous and linear fashion. There was much more variability, however, in the course of speech development among the blind children. Indeed, the blind children extended both the upper and lower limits of the range of variability observed among their sighted counterparts. Two blind children (Lydia and Teddy) produced more speech than did any of the sighted children;[3] two children (Kelli and Carlo) produced fewer words than did sighted children; and the remaining child (Lisa) fell within the range of variability observed among the sighted children.

The right-hand panels of Figure 1 display the amount of gesture produced by sighted and blind children, respectively, over developmental time. The measure presented here is the proportion of total meaningful communications containing gesture. This measure was obtained by dividing the total number of utterances containing gesture (i.e., gesture of all types, either alone or with speech) by the total number of utterances produced within a session (speech alone, gesture alone, gesture with speech).[4]

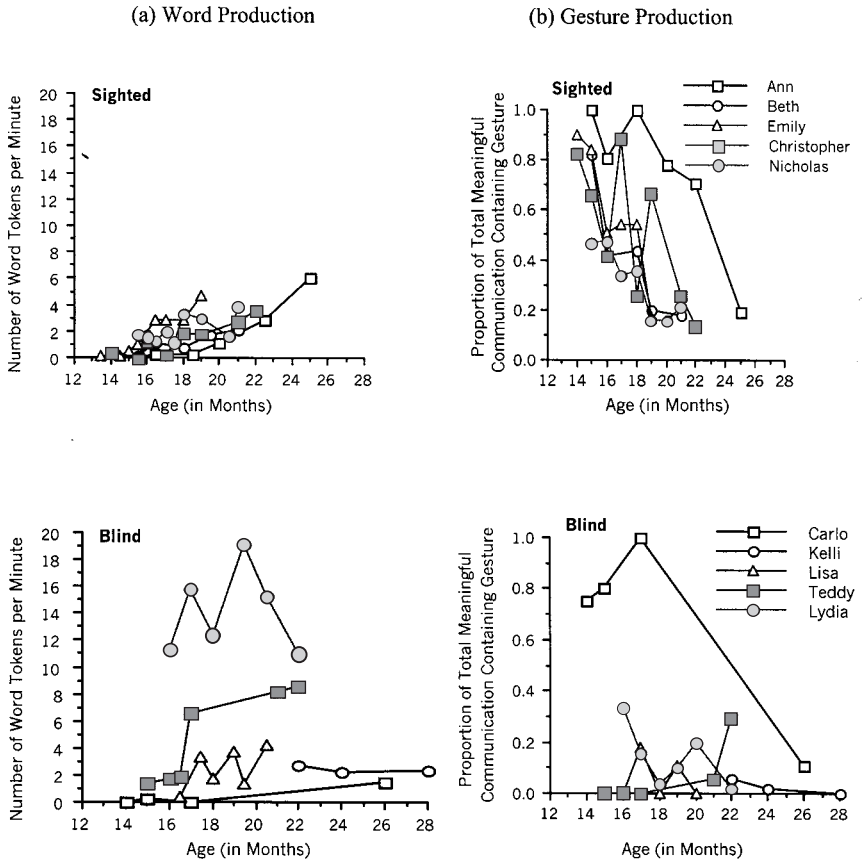


**Figure 1.** Word and gesture production by sighted and blind children over developmental time.

As is apparent in the figure, all of the blind children produced at least some gestures. However, the overall pattern of gesture production over time was quite different from that observed among sighted children. For most sighted children, the proportion of communications containing gesture was relatively high up to and including the 18-month session, after which it underwent a rapid decline. The blind children exhibited two patterns of gesture production. One child (Carlo) behaved rather like the sighted children, producing a high proportion of utterances containing gesture between 14 and 17 months, with a sharp decline at 26 months. For the other four blind children, however, the proportion of communications

containing gesture remained relatively low throughout all sessions. Interestingly, the blind children's patterns of gesture production showed no clear relationship to their pattern of speech production. In other words, it was not the case that substantial gesture use (e.g., Carlo) was associated with high word production, nor was infrequent gesture use (e.g., Teddy and Lydia) accompanied by relatively low word production.

Similarly large individual differences in gesture production have been reported for older blind children and adolescents (Iverson, 1998; Iverson & Goldin-Meadow, 1997). For example, in a recent study, Iverson (1999) examined gesture production in a group of congenitally blind children and adolescents (ages 8–18 years) across a variety of task contexts and reported large and consistent individual differences in gesture use across tasks. While some blind children gestured at the same rate as their sighted peers, others gestured very infrequently, if at all. Our findings extend these results and indicate that such individual variability may be apparent from early in the course of language development, and importantly, may be unrelated to language-learning in these children.

### *Types of Gestures*

We next examined the types of gestures produced by sighted and blind children. As described earlier, all gestures were classified into one of three categories: deictic, conventional, and reach/request. We calculated the proportion of gestures in each category for each child across all of the sessions. Figure 2 presents the mean proportions for each gesture type calculated separately for the blind and sighted groups.

The distribution of gesture types across categories was quite similar for the two groups. The vast majority of gestures produced by sighted and blind children (82% and 73%, respectively) were deictic gestures that served to indicate or draw attention to a referent. This pattern was evident in all 5 sighted children ($p = .03$, Sign Test) and in 3 blind children (ns.). Conventional and reach/request gestures followed, in that order. This is consistent with previous findings from observations of larger groups of sighted children indicating that deictic gestures tend to predominate in young children's communication (e.g., Iverson et al., 1994). Some authors have suggested that deictic gestures provide children with a means for working out the principles of referential communication (e.g., Bates et al., 1987). Conventional gestures and words carry fixed meanings and thus require the child to map specific gestural or verbal forms to specific referents. Deictic gestures, however, do not require mastery of these abstract symbol-referent mappings but can be used to single out objects in the envi-

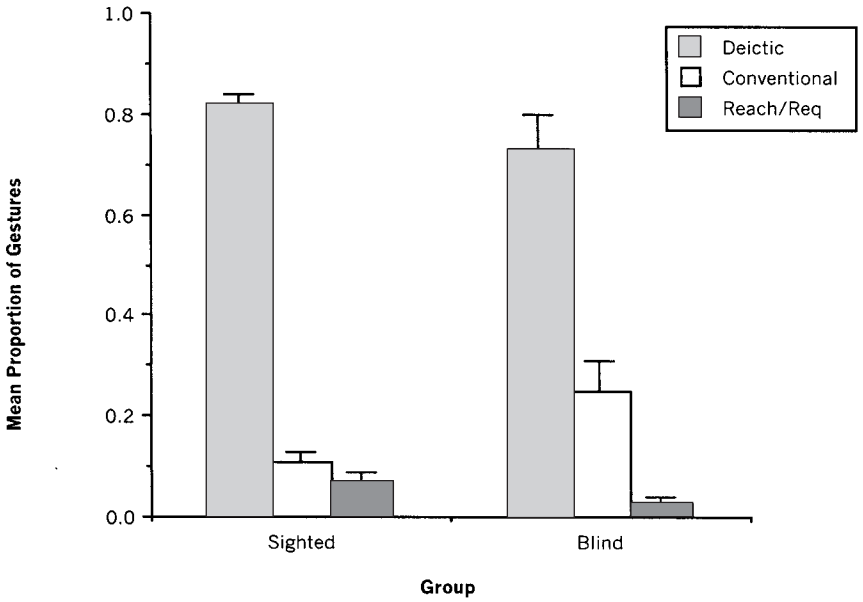


**Figure 2.** Mean proportion of gesture types produced by sighted and blind children.

ronment. In other words, the extensive use of deictic gestures observed here and in other studies may be partially attributed to the low demands they place on young children's developing symbolic abilities.

Interestingly, blind children on average produced over twice as many conventional gestures as did sighted children (25% vs. 11%, respectively), although only 2 of the 5 children exhibited this pattern (ns., Sign Test). Even more striking, however, is the fact that the set of conventional gestures observed in the blind children was comparable to the set observed in sighted children. Blind and sighted children shook their heads *no,* waved their hands *hi* or *bye-bye,* and *clapped* their hands to indicate approval or excitement at an event. Only two conventional gestures produced by the sighted children were not observed among the blind children—nodding the head *yes* and flipping the hands with palms upward to indicate *I don't know* or *where.*

How might blind children come to acquire such conventional gestures when they have no usable visual model for those gestures? One possibility is that conventional gestures arise for blind children in much the same way that they do for sighted children—appearing initially in the context of care-

giver-child routines and then becoming progressively more detached from the original context of production (e.g., Caselli, 1990; Piaget, 1951; Werner & Kaplan, 1963). In other words, children's first gestures are associated with specific situations and activities and are produced only in those settings. As children begin to understand that symbols can be used to "stand for" referents, there is a shift toward the distancing of a gesture from its referent, such that these gestural symbols begin to be produced across a wide variety of different contexts and in the absence of referents.

Thus, for example, a blind child's caregiver may take the child's hand and wave it back and forth as a person is leaving; ultimately, the child may generalize this action to other contexts, for example, spontaneously waving *bye-bye* as the car in which s/he is riding begins to pull out of the driveway. *Clapping* the hands to indicate excitement and/or approval may also emerge in this fashion. Indeed, in his classic discussion of the origins of emotional expressions, Darwin (1872) suggested that the origins of the headshake *no* may lie in the context of early feeding situations. Darwin noted that when young children refuse food, they frequently move their heads from side-to-side in a way that resembles the adult headshake. In his view, head movements associated with refusal in these early interactions are extrapolated from this specific context and eventually come to serve as a more general signal of negation.

The nature of the relationship between parental input, parent-child interaction, and the development of blind children's gestural repertoires is well beyond the scope of the present study and is clearly an issue that warrants future investigation. Nevertheless, information gleaned informally from the videotapes supports the view that at least some gestures are learned through routines. In the course of an early observation, Teddy and his mother engaged in a routine in which she would say, "Oh, Teddy's so pretty. He's such a pretty boy," while running her hands over his hair from the front to the back of his head. In later sessions, Teddy produced this gesture (running his hands through his own hair) on multiple occasions to refer to both objects and people. Apparently, *pretty* had been extracted from the context of a specific routine established between Teddy and his mother and, over time, became to be used by the child to refer to, and comment on, a variety of different referents in different contexts.

Thus far, we have shown that young congenitally blind children do gesture during early language development. Although the blind children produced fewer gestures than their sighted peers, both groups made use of the same types of gestures, with deictic gestures appearing most frequently. Consequently, we now focus our analyses on deictic gestures.

*Gesture Form*

Were there differences in the forms of the deictic gestures produced by sighted and blind children? We analyzed gesture form in two ways: by examining the *form of the hand*, and by examining the *location of the referent* toward which the gesture was directed.

*Hand form.* As described previously, all deictic gestures were classified into one of three categories: *Index point* (with clear extension of the index finger), *Palm point* (flat hand with all fingers extended), and *Show* (holding an object up and into the communicative partner's potential line of sight). We calculated the proportion of gestures that fell into each deictic category for each child across all of the sessions. The top panel of Figure 3 presents the mean proportions for each deictic type calculated separately for the sighted and blind groups.

As is evident from the figure, the distribution of gesture forms across categories was strikingly different for sighted and blind children. Four of the 5 sighted children used Index points most frequently, Shows almost as often, and Palm points rarely. In contrast, all 5 blind children used Palm points most frequently, a small proportion of Shows, and almost no Index points ($p = .03$, Sign Test).

*Location of referents.* We classified the referent of each deictic gesture according to whether it was *proximally located* (i.e., at arm's distance or closer and thus within touching range) or *distally located* (i.e., at a distance greater than arm's length and thus beyond touching range). Gestures referring to proximal objects were further classified according to whether they touched the referent or not. Because Showing by definition involves contact with the referent, this analysis was carried out only on the referents of Index point and Palm point gestures. We calculated the proportion of pointing gestures that fell into each location category for each child across all of the sessions. The bottom panel of Figure 3 presents the mean proportions for each location calculated separately for the sighted and blind groups.

Both sighted and blind children used Index and Palm points primarily to refer to objects that were within reach, that is, to proximally-located rather than distally-located objects. This pattern held for the 5 sighted children ($p = .03$, Sign Test) and the 5 blind children ($p = .03$, Sign Test). However, the children differed in the frequency with which they actually touched the object to which their gesture referred. The sighted children touched the object with their points in approximately 60% of their refer-

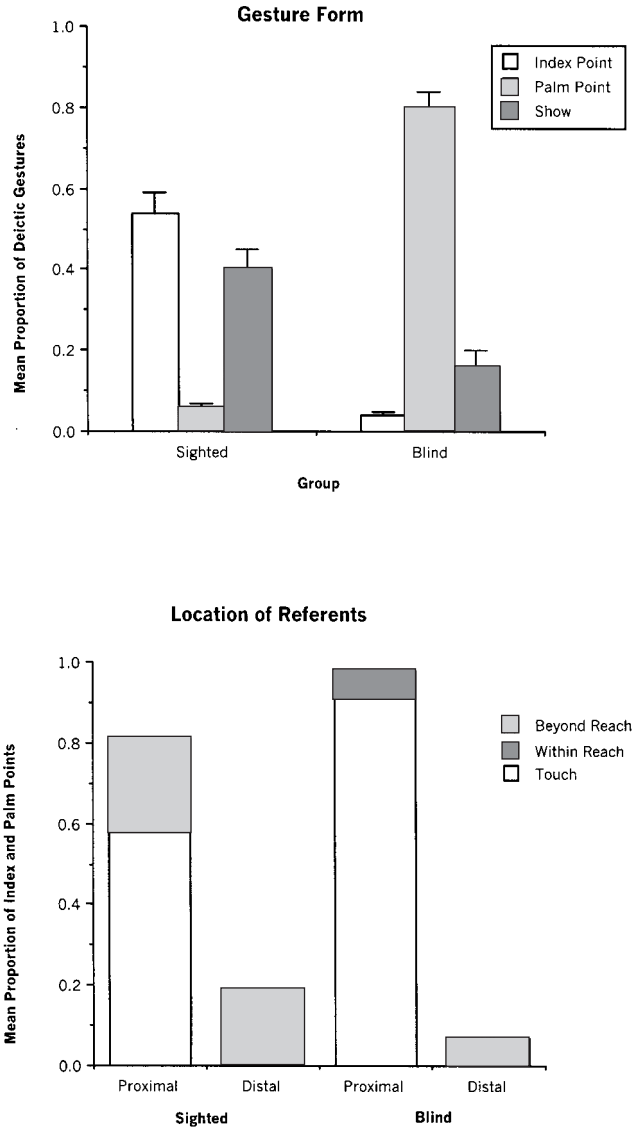


**Figure 3.** Forms of deictic gestures and location of referents indicated by deictic gestures for sighted and blind children.

ences to proximal objects, while the blind children did so in 90% of their proximal references.[5] In terms of distal objects, the data in the figure indicate that sighted children on average used gestures more frequently to refer to out-of-reach objects than blind children, but this difference was not statistically reliable. However, all 5 of the sighted children occasionally used their gestures to refer to objects that were not within reach (and obviously were not touched; $p = .03$, Sign Test), while only one blind child did (Lydia, the child with some residual vision).

In sum, congenitally blind children did use gestures during the initial stages of language acquisition, and the forms of their gestures fit within the range of forms used by sighted children of the same age. However, the distribution of those forms differed sharply for the two groups. Blind children used gesture to call attention to specific objects in the environment, but they did so using Palm points rather Index points. Why might this be the case? When sighted children produce an Index point, they in effect establish a "visual line of regard" extending from the pointer's eyes along the length of the arm and pointing finger toward the referent of the gesture. Index points localize the indicated referent with considerable precision—much more precision than the Palm point. It may be that blind children, who cannot use vision to set up a line between the eyes, the index finger, and the gestural referent in distant space, are not able to achieve the kind of precise localization that the Index point affords (indeed, demands). They may therefore make use of the less precise Palm point.

In addition, blind children used deictic gestures almost exclusively to refer to objects that were within reach; only one blind child in our sample used points to refer to distally located objects. In contrast, sighted children used deictic gestures to communicate about both distally located and proximally located objects. Moreover, when they referred to proximally located objects, blind children actually touched the object with their gestures almost all of the time, while sighted children did so only 60% of the time; all 5 sighted children at times indicated proximal objects without making physical contact with the referent.

### *Object References in Speech and Gesture*

Are there differences in the types of objects sighted and blind children refer to using speech and gesture? We first categorized all of the objects that children referred to in either gesture or speech and assigned them to one of several categories: small objects, animals, people, food/drink, body parts, furniture, vehicles, named toys (e.g., Donald Duck), clothing, and nearby locations.[6] We found that both blind and sighted children referred

to the same overall set of objects. No category of items was mentioned by blind but not sighted children, and vice versa. This finding is consistent with previous reports that the general composition of blind and sighted children's early vocabularies does not differ (e.g., Bigelow, 1987; Landau & Gleitman, 1985). We next examined the modalities that each child used to refer to particular objects.

*Modalities used to refer to objects.* For the first analysis, we identified all instances in which children referred to an object[7] and examined the modalities in which the reference occurred: *speech-only* (e.g., saying "ball"), *gesture-only* (e.g., pointing to the ball), or *speech-and-gesture* (e.g., saying "ball" and pointing to the ball). This analysis was based on types (rather than tokens) within a session. For example, if a child only pointed at a ball during the session, BALL was counted as one type in the "gesture-only" category. If the child only said "ball" during the session, BALL was counted as one type in the "speech-only" category. If a child produced the word "ball" early in the session and pointed at a ball later in that same session, we counted BALL as one type in the "speech-and-gesture" category (the child could also have produced the gesture and the word simultaneously). Other investigators have reported that children tend to acquire lexical items first in one modality, and that the items become available to both modalities at a later point in development (e.g., Acredolo & Goodwyn, 1988). Thus, the speech-and-gesture category was included in order to distinguish items that were produced uniquely in one modality from those that appeared in both modalities. We calculated the proportion of items (summed across sessions) that each child produced in each of the three categories. These data are presented in Table 2.

With the exception of one blind child (Carlo, who on average made only 1 reference to an object per hour), sighted and blind children were comparable in their overall number of object references per hour across sessions (for sighted children, range 4.0–8.1; for blind children, range 5.6–9.1). However, there were sharp differences in the extent to which children in the two groups used words and gestures to refer to objects. For sighted children, most object references occurred in gesture, either alone or with speech, a pattern that was apparent in all 5 children ($p = .03$, Sign Test). Interestingly, for three children (Christopher, Emily, Ann), over 60% of all items appeared uniquely in gesture. The remaining children (Nicholas and Beth) referred to roughly equal proportions of objects in speech-only and in gesture-only.

For blind children, there was greater individual variability in the distribution of objects across the three modality categories. Three of the chil-

**TABLE 2**

**Mean Proportion of Objects Referred to in Speech Only, Gesture Only, and Speech and Gesture by Sighted and Blind Children (summed across sessions)**

| | Mean object references per hour | Speech only | Gesture only | Speech and gesture | N |
|---|---|---|---|---|---|
| *Sighted Children* | | | | | |
| Christopher | 5.9 | .27 | .67 | .06 | 177 |
| Emily | 6.0 | .15 | .68 | .17 | 174 |
| Nicholas | 5.5 | .40 | .42 | .18 | 218 |
| Beth | 4.0 | .40 | .40 | .20 | 92 |
| Ann | 8.1 | .15 | .66 | .19 | 162 |
| *Blind Children* | | | | | |
| Carlo | 0.7 | .50 | .50 | .00 | 18 |
| Kelli | 5.6 | .41 | .53 | .06 | 26 |
| Lisa | 6.7 | .85 | .05 | .10 | 37 |
| Teddy | 6.6 | .90 | .04 | .06 | 43 |
| Lydia | 9.1 | .69 | .15 | .17 | 88 |

dren (Lisa, Teddy, Lydia) referred to objects primarily in speech-only. The other two blind children (Kelli and Carlo) made approximately 50% of their object references in gesture-only, and thus resembled two of the sighted children (Nicholas and Beth). Note that these 2 blind children produced fewer words per minute than the other 3 blind children and than all 5 of the sighted children (see Figure 1a), and that both children began producing two-word combinations later than any of the other blind or sighted children (see Table 1). The prevalence of gesture-only references was clearly not associated with early competence in speech in these two blind children.[8]

Thus, while the sighted children relied extensively on gesture when referring to objects, the blind children were more variable, with some making use of gesture and others relying primarily on speech. Interestingly, neither group used both modalities to refer to a single referent very frequently. In other words, there appeared to be very little overlap between a child's gestural referents and that child's spoken referents. Thus, at this

early stage in word-learning, children—both blind and sighted—tended to refer to objects either with words or with gestures, but not both (cf. Acredolo & Goodwyn, 1988; Volterra, 1981).

*Developmental patterns in using gesture vs. speech to refer to objects.* We next inspected the data from the individual sessions of each sighted child to determine whether there was a developmental shift in the prevalence of items referred to in speech-only vs. gesture. The blind children were excluded from this analysis because they produced so few items in gesture-only at all points during the observation sessions. Prior work suggests that sighted children shift their preferred mode of communication from gesture to speech sometime between the ages of 16 and 20 months, beginning to use words more frequently than gestures at this moment to label objects in experimental tasks (Bretherton et al., 1981) and in spontaneous communication (Iverson et al., 1994). We suspected that a similar shift might also be evident in children's spontaneous references to objects. The number of object references that each sighted child made in speech-only and in gesture-only is plotted over developmental time in Figure 4. As in Table 2, this analysis is based on types within a session.

At the beginning of the study, all five sighted children referred to more objects in gesture-only than in speech-only ($p = .03$, Sign Test), and the difference between the number of items in the two modalities remained relatively constant until the child reached approximately 18 months of age. By the final few sessions, the number of items in speech-only equaled, or surpassed, the number of items in gesture-only for each child. The figure shows longitudinally, for each individual child, what is often shown only at the group level: Initially, the child relies on gesture and then gradually comes to rely more and more on speech. Moreover, the crossover point, when speech begins to assume dominance, occurs at around 18 months for most children.

The data presented thus far suggest that, at least for sighted children, gesture may serve a "bootstrapping" function in lexical development by providing a way for the child to refer to objects in the environment without actually having to produce the appropriate verbal label. If this is the case, we might expect an individual lexical item to enter a child's repertoire first in gesture, and then over time transfer to speech. To explore this possibility, we conducted a third analysis, focusing on items that children referred to in multiple sessions. For each item, we looked at the sessions in which they occurred to determine whether they initially appeared and remained in a single modality (i.e., speech-only or gesture-only) across sessions, or whether they appeared in more than one modality across sessions. For this

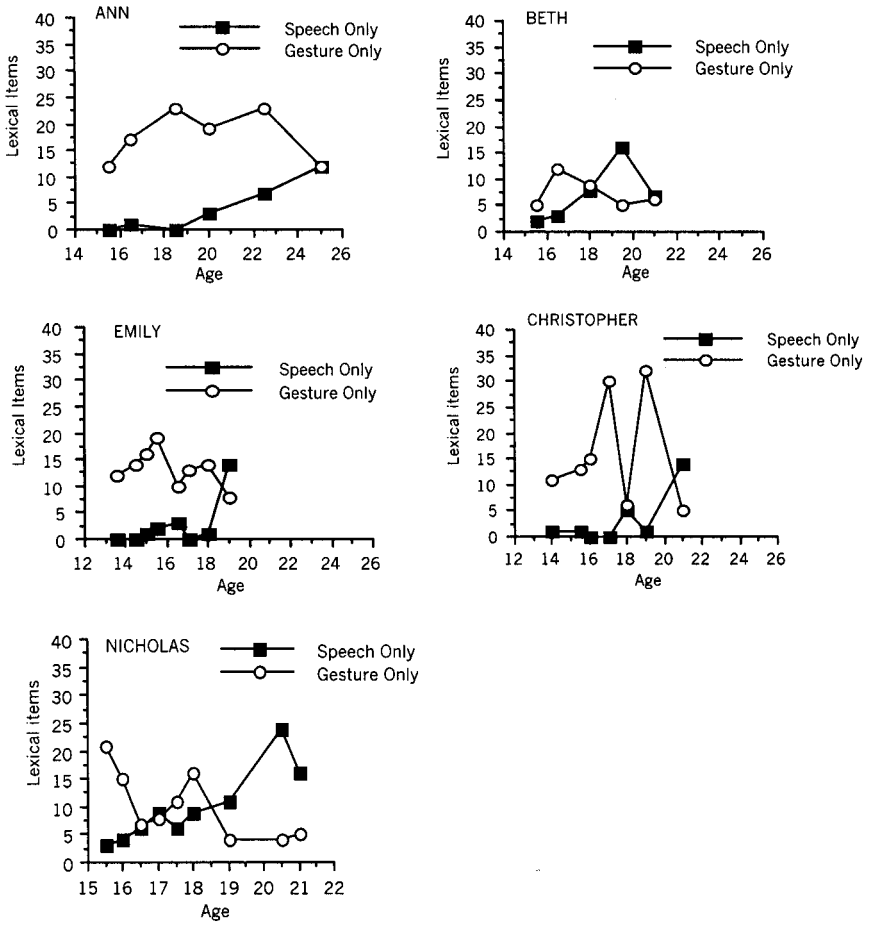


**Figure 4.** Number of lexical items in speech only and gesture only produced by sighted children over developmental time.

latter category, we noted whether the item appeared first in speech and subsequently in gesture, first in gesture and subsequently in speech, or in both modalities simultaneously. These data are presented in Table 3.

There was a strong tendency for items produced in multiple sessions either to remain in gesture-only throughout the period of observation, or to appear initially in gesture and then in speech in a subsequent session. Over half of the items produced by individual sighted children fell within these two categories (range 51%–92%). In line with the findings described

**TABLE 3**

**Developmental History of Lexical Items Appearing in Multiple Sessions**

| | Items in one modality | | Items in both modalities | | |
|---|---|---|---|---|---|
| | In speech throughout | In gesture throughout | First in speech | First in gesture | Both speech and gesture |
| *Sighted Children* | | | | | |
| Christopher | 1 | 11 | 2 | 24 | 0 |
| Emily | 0 | 13 | 1 | 16 | 11 |
| Nicholas | 6 | 12 | 9 | 13 | 9 |
| Beth | 2 | 3 | 1 | 12 | 1 |
| Ann | 1 | 8 | 2 | 13 | 5 |
| *Blind Children* | | | | | |
| Carlo | 0 | 0 | 0 | 0 | 0 |
| Kelli | 2 | 0 | 0 | 0 | 1 |
| Lisa | 4 | 0 | 2 | 0 | 0 |
| Teddy | 4 | 0 | 1 | 0 | 0 |
| Lydia | 8 | 2 | 2 | 3 | 6 |

above, it was relatively uncommon for items to appear initially in speech. With the exception of one sighted child (Nicholas, for whom 30% of items appearing in multiple sessions were produced initially in speech), only a small proportion of items occurring across sessions were produced either first in speech or in speech throughout (range 2%–16%). A similar analysis conducted with data from the blind children revealed a different pattern. For 4 of the 5 children (the exception is Lydia), items that appeared across several sessions tended to remain in speech throughout the period of observation.

Taken together, results from the analysis of object references suggest that, for sighted children, gesture plays an important role in lexical development, providing a way of referring to objects that cannot yet be labeled in speech. In the initial observations, the sighted children in this study referred to more items in gesture than in speech. By the end of the period of observation, however, the number of items referred to in speech had begun to exceed those in gesture. In addition, for lexical items that appeared in multiple sessions, the vast majority either remained in gesture

throughout the period of observation or appeared in gesture first and subsequently moved to speech. These data are consistent with the notion that gesture may serve as a transitional device in early language development. Because the relation between a deictic gesture and its referent is more transparent than the highly arbitrary relation between most words and their referents, gesture may provide children with a temporary way to communicate about objects while circumventing difficulties related to the production of abstract verbal symbols (Acredolo & Goodwyn, 1988; Werner & Kaplan, 1963).

While gesture may play an important role in lexical development for sighted children, it does not appear to serve the same function for blind children. The blind children in our study relied almost exclusively on speech when referring to objects, a pattern maintained throughout the period of observation. In addition, when blind children produced gestures, the vast majority were used to refer to objects that they could touch; few, if any, gestures were ever used to communicate about distally located objects. By contrast, sighted children used gestures much more frequently to refer to objects that were more distally located. This pattern of findings is consistent with observations reported by Urwin (1979), who suggested that lack of vision and consequent limitations on access to the surrounding context may limit the range of communicative devices available to young blind children. While sighted children have several options available for communicating about distally located referents, blind children's communication may be more restricted to the immediate context because they can neither look at, nor use, gestures to refer to objects outside of their immediate perception.

### *Conclusion*

We have found that sighted children rely heavily on gesture at the earliest stages of word-learning, and thus have extended previous reports of the role gesture plays in lexical development in young sighted children (Acredolo & Goodwyn, 1988; Bates, 1976; Iverson et al., 1994). All 5 of the sighted children in our sample used gesture alone more than speech alone to refer to objects, and very few children referred to a single object using both gesture and speech. This is consistent with prior work on symbolic gesturing by Acredolo and Goodwyn (1985, 1988), whose analyses of parental interview and diary data revealed that items tend to appear first in gesture and only later transfer to speech. Our observational data confirm and extend these findings to another category of gestures, deictic gestures.

Thus, gesture may well be an important language-learning device for children who have normal vision.

Our findings suggest, however, that gesture does *not* play a similar role in blind children's communicative repertoires. Clearly, these results must be interpreted with caution in light of the small number of blind children in this study and the high degree of individual variability in their communicative behavior. Nonetheless, our data underscore three points. First, blind children gesture at the earliest stages of word-learning, and they have the same types of gestures in their repertoires as sighted children. Gesture thus emerges even when no visual model is available, suggesting that it is indeed a robust component of human communication.

Second, blind children appear to rely on gesture to a lesser degree than do sighted children. Thus, while visual input may not be essential for the *emergence* of gesture, the absence of vision appears to influence the extent to which young blind children use gesture to communicate, in most cases, dramatically decreasing its rate. Gesture may be used relatively infrequently by blind children because it is presumably a less efficient means of communication. Blind children cannot alternate their gaze between the referent and the adult with whom they are communicating. While sighted children can follow the gaze of their listener to determine whether their gestures have been apprehended, blind children must rely on explicit verbal feedback from the listener to ascertain that their gestural message has been received. Some of the efficiency that gesture offers sighted children is therefore inaccessible to blind children. Thus, while sighted children used deictic gestures to establish reference to distally located objects, reference to such objects may be difficult for blind children, simply because the location of the object is outside their immediate perceptual field.

Third, despite the fact that the blind children used gesture much less and in different ways than did sighted children, they did *not* appear to exhibit extreme delays in language-learning. Moreover, the individual variability observed in blind children's gesture use was not related in any obvious way to their progress in spoken language. Some of the blind children gestured as much as their sighted peers, while others gestured only rarely. However, we found no evidence of differences on any of our measures of communicative competence (see Table 1) between blind children who gestured a great deal and those who gestured a little. The absence of such differences is somewhat surprising in light of prior reports of positive relationships between gesture use and aspects of language development in sighted children (Goldin-Meadow & Butcher, 2000; Iverson et al., 1994), and other research indicating that low rates of gesture use may be a good indicator of risk for language delay (Thal & Tobias, 1991, 1994; Thal, To-

bias, & Morrison, 1994). Such findings might have led us to expect decreased or delayed communication in blind children who gestured infrequently. But this was not the case, at least not for any of the milestone measures considered here. The fact that we did not find evidence of such delays suggests that gesture may *not* be essential for language-learning.

However, our findings leave open the possibility that gesture may play an enabling role in word-learning for sighted, albeit not for blind, children. For example, when sighted children use gestures to communicate about objects (e.g., pointing at a cup), they frequently elicit a response from the listener, responses that provide them with valuable information about the name and characteristics of the object they have singled out (e.g., "Yes, that's a cup. It's a red cup. It has milk in it now."). Gesture may then be a useful tool that allows sighted children to elicit language-learning data from their communication partners. Blind children, however, must find a different means for gathering the same data, and recent research suggests that they do indeed develop alternative strategies for language-learning (see Conti-Ramsden & Pérez-Pereira, 1999, for a review and extensive discussion of this issue). For example, blind children may rely extensively on speech for communicative purposes and focus interactions on objects that are within their immediate perceptual field because they lack easy access to gesture to refer to distal objects. Such a strategy should not be viewed as deficient but as one that allows the child to be an efficient language learner when visual input is not available. It is striking, indeed, that children are such good language-learners that even a complete lack of visual input presents little impediment to the language-learning process (cf. Landau & Gleitman, 1985).

In sum, we have found that, for sighted children, gesture is an important vehicle for conveying information that is not yet available verbally. The small set of blind children that we observed did not exhibit comparable distributions of speech and gesture production, yet their linguistic development was relatively unaffected. Gesture may thus play different roles in the language-learning process for sighted and blind children. Nevertheless, it is important to stress that blind children at the earliest stages of language learning can gesture. Experience with a visual model is therefore not essential for gesture to emerge in the language-learning child.

## Notes

1. The legal definition of blindness requires that visual acuity in the better eye with correction be no greater that $^{20}/_{200}$ Snellen, but this is an amount of vision that is quite different from the common conception of blindness as the total absence of visual information. Thus,

there is a great deal of variability in extent of visual impairment among persons who are categorized as "blind." For the most part, our sample is relatively homogenous in that the majority of the blind children had severe congenital visual impairments, at best minimal light perception, and no functional vision. Lydia's small amount of peripheral form vision clearly makes her an exception; indeed, other researchers have reported that children with minimal residual vision tend to behave more like their sighted than their blind peers (e.g., Andersen et al., 1984).

2. Note that studies in the area of child language typically involve small numbers of participants and the analysis of descriptive data, which facilitates comparison between our data and those described in the literature.
3. This pattern suggests that there is no direct relationship between extent of visual impairment and children's developing language skills. While Lydia has some residual vision, Teddy's visual impairment is the most severe of the group.
4. It is important to note that, in describing these same sighted children, Butcher and Goldin-Meadow (in press) used a different estimate of total communication than we used here. In particular, they included in their measure meaningless vocalizations—vocalizations that were used communicatively but did not have a consistent form (e.g., a grunting sound produced when attempting to get mother's attention). When gesture production is calculated as a proportion of this total, it remains flat across the developmental period studied; that is, it does not decline but is constant across this age range (see Figure 1 in Butcher & Goldin-Meadow, in press). In recoding the blind and sighted children, we did not attempt to isolate meaningless vocalizations; thus, our communications included only those that had identifiable referents.
5. Recall that stringent criteria were employed for all of the children (e.g., presence of eye contact, vocalization, or other evidence of effort to draw the listener's attention) to ensure that the gestures, including touch points, were communicative acts and not simply instances of object manipulation.
6. Data from these analyses are available from the authors.
7. Only nouns and deictic gestures were included in this and all subsequent analyses. While children used both nouns and pronouns to refer to objects, we excluded pronouns from the data reported here because they were relatively infrequent (accounting for 20% of sighted and 12% of blind children's verbal object references). In addition, the meaning of a pronoun depends entirely on the nonlinguistic context in which it is used, thus pronouns do not single out objects in the way that nouns do. All of the analyses reported below were repeated with pronouns included, and there were no differences between these results and those obtained with only nouns included.
8. An important difference between Kelli and Carlo and the other blind children is that both children were born several months premature, while the remaining three were born at term. There is now an ample body of research indicating that preterm children's acquisition of language is somewhat delayed relative to full-term children (e.g., Menyuk, Liebergott, & Schultz, 1995), particularly when their abilities are evaluated on the basis of chronological age, as they were in the present study. If the children's ages are corrected for prematurity (i.e., calculated on the basis of gestational age, rather than date of birth), the ages at which they attained the two language milestones considered here fall well within the ranges observed among our sighted children.

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