Gesture and the transition from one- to two-word speech: when hand and mouth come together

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1 Introduction

Despite the fact that they are produced in different modalities, gesture and speech form a unified communication system in adults. To explore whether symbolic communicative gesture and speech form a single system in young children, three girls and three boys were observed longitudinally during the transition from one- to two-word speech. Initially, gesture tended to be produced without speech, and, on the rare occasions when it was combined with speech, that speech was meaningless and not synchronized with the accompanying gesture. The two characteristics that define integration in adult speakers – semantic coherence (combining gesture with meaningful and related speech) and temporal synchrony (producing gesture in synchrony with speech) – were found to emerge in the children’s communications at the same moment and prior to the onset of two-word speech. The onset of gesture–speech integration thus occurs during the one-word period and before words are combined with other words.

Adults and children typically express their thoughts in speech, and, along with that speech, they spontaneously produce gestures. Despite the fact that they are produced in different modalities, gesture and speech deliver a coherent message to the listener (Alibali, Flevares & Goldin-Meadow 1997; Goldin-Meadow & Sandhofer 1999; Goldin-Meadow, Wein & Chang 1992; McNeill, Cassell & McCullough 1994) and thus can be said to form a single unified communication system (Goldin-Meadow 1997; Goldin-Meadow, Alibali & Church 1993; McNeill 1985, 1992). According to McNeill (1992), this coherence is possible because gesture and speech share a common cognitive representation; that is, before the communication
unfolds, gesture and speech are part of a single idea. As expression proceeds, the message is parsed, with most information channeled into speech but some information channeled into gesture. The coordination of gesture and speech to convey a single message, and particularly the origins of such coordination, form the cornerstone of this study.

1.1 Gesture and speech form an integrated system in adult speakers

Evidence that gesture and speech form a single, unified system in adult speakers comes from two sources. First, gestures and speech are semantically and pragmatically co-expressive. When people speak, they produce a variety of gesture types (iconics, metaphors, beats, cohesive, deictics; cf. McNeill 1992), and each type of gesture has a characteristic type of speech with which it occurs. For example, iconic gestures have a transparent relationship to the ideas they convey; iconics accompany utterances that depict objects and events and fulfill a narrative function (i.e., they accompany the speech that 'tells the story'). As an instance, a speaker produced the following iconic gesture when describing a scene from a comic book in which a character bends a tree back to the ground: the speaker grasped his hand as though gripping something and pulled his hand back. He produced this gesture as he uttered the words "and he bends it way back," a concrete description of an event in the story.

In contrast, metaphoric gestures are also pictorial but represent an abstract idea rather than a concrete object or event; metaphors accompany utterances that refer to the pragmatic structure of the discourse as a whole. As an instance, a speaker produced the following metaphoric gesture when announcing that what he had just seen and was about to recount was a cartoon: the speaker raised his hands as though he were offering an object to the listener—a pictorial representation of the cartoon as a whole, but not a concrete one. He produced this gesture as he said, "It was a Sylvester and Tweety cartoon," an utterance which set up and introduced the topic of discussion rather than forming part of the storyline. Other gesture types similarly have their own parallels with speech (see McNeill 1992: ch. 7), suggesting a linked relationship between the two modalities.

It is important to note that, although the information conveyed by gesture is, for the most part, related in some way to the information conveyed by speech, the particular information conveyed by the two modalities need not be identical. For example, when describing Granny's chase after Sylvester in a cartoon narrative, a speaker moved her hand as though swinging an object while saying, "She chases him out again" (McNeill 1992). Speech conveyed the ideas of pursuit and recurrence, but gesture conveyed the weapon used (an umbrella) during the chase. Thus, the two modalities may present gesture and speech share during the speech act.

The second source of system comes from the Gesture is rarely produced independently, e.g., the OK McNeill (1992) found that when the gesturer was not bound to each other in time, they were synchronized temporally within a single utterance, using the same information at the same time, and at the same time. As an instance, the speaker produced "it way back" (see Kita et al.) to adjust to each other's evidence that the timing of the spoken word is that gesture and speech speech-production protocol speaker is presenting the moment and that gesture and speech.

These findings strongly convey a single message of the same meaning and are conveyed in the two modalities of the origins of such a development. Is gesture communications of you? modalities emerge at a certain point? We explored the role of from the production of Nations.

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modalities may present different aspects of the same event, suggesting that
gesture and speech share a common cognitive representation at some point
during the speech act.

The second source of evidence that gesture and speech form a unified
system comes from the fact that the two are almost always synchronous.
Gesture is rarely produced on its own in adults (except in the form of an
emblem, e.g., the OK sign; see Kendon 1981 for discussion). Indeed,
McNeill (1992) found that 90 percent of gestures in adults were produced
when the gesturer was speaking. Thus, acts of speaking and gesturing are
bound to each other in time at a general level. Moreover, gesture and speech
are synchronized temporally at another, more refined level as well; even
within a single utterance, the gesture and the linguistic segment represent-
ing the same information as that gesture are co-temporal. Specifically,
the gesture movement – the ‘stroke’ – lines up in time with the equivalent lin-
guistic segment. As an example, in the description of an iconic gesture
above, the speaker produced the stroke of the gesture just as he said, “bends
it way back” (see Kita 1993 for more subtle examples of how speech and
gesture adjust to each other in timing; Morrel-Samuels & Krauss 1992 for
evidence that the timing of gesture and speech is related to the rated famil-
ilarity of the spoken word; and Mayberry, Jaques & DeDe 1998 for evidence
that gesture and speech are synchronized even when, as in stuttering, the
speech-production process goes awry). Such synchrony implies that the
speaker is presenting the same meaning in both channels at the same
moment and that gesture and speech form a single integrated system.

These findings strongly suggest that gesture and speech work together to
convey a single message integrated in both time (synchrony across the two
modalities) and meaning (semantic coherence across the information con-
veyed in the two modalities) in adults. However, there is little work explor-
ing the origins of such a system in children at the earliest stages of language
development. Is gesture–speech integration characteristic of the earliest
communications of young children, or does integration across the two
modalities emerge at a consistent point in the young child’s linguistic de-
velopment? We explored this question in six children observed longitudinally
from the production of single words to the production of two-word combi-
nations.

1.2 Gesture in the one-word period of language development

At a time when children are limited in what they can say, there is another
avenue of expression that may be open to them. In addition to speaking, the
child can also gesture (cf. Bates 1976; Bates, Benigni, Bretherton, Camaioni
& Volterra 1979; Petitto 1988). The use of gesture during the one-word
period can extend the range of ideas children can express. For example, Acredolo & Goodwyn (1985) describe a young language-learner in the one-word period who used gestures rather than words to refer to certain objects; for this child, a referent object was symbolized by either a gesture or a word, but not both (see also Acredolo & Goodwyn 1988, who describe this same phenomenon in a larger sample of children). In fact, in a study of twelve Italian children in the one-word period, Iverson, Capirci & Caselli (1994) showed that eight of the children exhibited a clear preference for communication in the gestural modality over the verbal modality.

Combining gesture and speech within a single utterance can also increase the communicative range available to the child. Most of the gesture–speech combinations that young children produce contain gestures that convey information redundant with the information conveyed in speech; for example, pointing at an object while naming it (de Laguna 1927; Greenfield & Smith 1976; Guillaume 1927; Leopold 1949). However, young children have also been found to produce gesture–speech combinations in which gesture conveys information that is different from the information conveyed in speech; for example, gesturing at an object while describing in speech the action to be done on the object (pointing to an apple and saying, “Give”), or gesturing at an object and describing in speech the owner of that object (pointing at a toy and saying, “Mine”); Boswell 1988; Goldin-Meadow & Morford 1985; Greenfield & Smith 1976; Masur 1982, 1983; Morford & Goldin-Meadow 1992; Volterra & Iverson 1995; Zinober & Martlew 1985). This second type of gesture–speech combination allows a child to express two elements of a sentence (one in gesture and one in speech) at a time when the child may not be able to express those elements within a single spoken utterance.

Given that young children do use gesture communicatively during the one-word period of language development, and given that adults’ gestures are integrated with speech in both timing and meaning, the question naturally arises as to whether communicative gesture forms an integrated system with speech in the one-word speaker as well. Is there a time early in development when communicative gesture is used primarily without speech? If young children do produce gesture in combination with speech, are the two modalities integrated both temporally and semantically, as they are in adult systems? This study was designed to address these questions.

2 Method

2.1 Subjects and procedure

The subjects for this study were six children, three boys and three girls, videotaped in their homes over a period of months. Videotaping began
When hand and mouth come together

Table 12.1. Subject information

<table>
<thead>
<tr>
<th>First name</th>
<th>Sex</th>
<th>Ages observed</th>
<th>No. of sessions observed</th>
<th>Age of first meaningful word</th>
<th>Age of two-word combination</th>
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</thead>
<tbody>
<tr>
<td>Christopher</td>
<td>M</td>
<td>12 to 23.5 mo.</td>
<td>11</td>
<td>13.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Emily</td>
<td>F</td>
<td>13.5 to 19 mo.</td>
<td>9</td>
<td>13.5^a</td>
<td>18.0</td>
</tr>
<tr>
<td>Nicholas</td>
<td>M</td>
<td>15.5 to 21 mo.</td>
<td>11</td>
<td>15.5^a</td>
<td>18.5</td>
</tr>
<tr>
<td>Beth</td>
<td>F</td>
<td>15.5 to 21 mo.</td>
<td>5</td>
<td>15.5^a</td>
<td>18.0</td>
</tr>
<tr>
<td>Ann</td>
<td>F</td>
<td>15.5 to 25 mo.</td>
<td>6</td>
<td>16.5</td>
<td>22.5</td>
</tr>
<tr>
<td>Joseph</td>
<td>M</td>
<td>21 to 27.5 mo.</td>
<td>10</td>
<td>21.0^a</td>
<td>26.5</td>
</tr>
</tbody>
</table>

Note:
^a These four children produced meaningful words during their first observation sessions.

when each child was in the one-word period of language development, and continued until the child began producing two-word combinations. Four of the six children were seen approximately every 2 weeks (except when weather, illness, vacations, etc. delayed taping sessions); the remaining two subjects were seen approximately every 6 to 8 weeks. Table 12.1 reports the age range during which each child was observed and the number of videotaped sessions conducted during this period.1

All of the data were collected in spontaneous play situations during which the children interacted with their primary caregivers and/or the experimenter. In order to facilitate conversation and provide consistent stimuli across subjects, two large bags of toys and books were brought to the child’s home by the experimenter (see Goldin-Meadow 1979 and Goldin-Meadow & Morford 1985 for further information on the toys and procedures). The play session was not structured by the experimenter, and parents were encouraged to engage their children in conversation. The play sessions lasted approximately one hour.

2.2 Identifying and coding communicative utterances

We focused in this study on gesture and speech that was used communicatively. All of the communicative gestures and vocalizations produced by each child during a half-hour of videotape were transcribed and coded. If that half-hour did not yield one hundred communicative behaviors, additional tape was coded until one hundred behaviors were transcribed. A communicative behavior was defined as either a gesture on its own, speech on its own (either meaningless or meaningful; see below), or a gesture and speech produced together. The mean number of minutes transcribed per
session for each child was: Ann, 41 minutes; Beth, 48; Emily, 30; Christopher, 33; Nicholas, 31; and Joseph, 39.

2.2.1 Coding speech. All of the communicative vocalizations that each child produced were coded and classified into one of two categories. (1) 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 “bahi” to refer to a bottle). (2) Meaningless vocalizations were speech sounds that were not used consistently to refer to a particular referent but appeared to be communicative nonetheless; that is, they were directed toward another individual (e.g., the child looks at a picture, produces the sound “bub,” and looks up at the adult; “bub” does not have any apparent relation to the object in the picture, which was neither a ball, a book, nor anything whose name began with ‘b’, but it does appear to have been produced for the benefit of the listener).

2.2.2 Coding gesture. The criteria for isolating gestures grew out of a concern that the gestures meet the minimal requirements for a communicative symbol (see Goldin-Meadow & Mylander 1984 and Butcher, Mylander & Goldin-Meadow 1991 for discussion) and were as follows:

(1) The gesture must be directed to another individual; that is, it must be communicative. In particular, we required that the child establish eye contact with a communication partner, or be assured of the partner’s attention, in order for the child’s act to be considered a gesture.

(2) The gesture must not itself be a direct manipulation of some relevant person or object (i.e., it must be empty-handed; cf. Petitto 1988). When a child puts a telephone to the ear and pretends to have a conversation, it is not clear whether that act should be regarded as designating the act of telephoning (and therefore a symbol), or as the child’s attempts to practice the act of telephoning (and therefore not symbolic at all; cf. Huttenlocher & Higgins 1978). To be conservative, all acts that were done on objects were excluded, with one exception – if a child held up an object to bring it to another’s attention, an act that serves the same function as the pointing gesture, it was counted as a gesture. In addition, functional acts were not considered gestures; for example, neither holding out an object to transfer it to another person nor reaching for an object was considered a gesture. However, if the child extended a hand toward the desired object (but did not try to capture it) and looked at the experimenter, this act was not a direct act on the object and thus was considered a gesture (cf. Masur 1983).

(3) The gesture must not be part of a ritual act (e.g., to blow a kiss as someone leaves the house) or game (e.g., patty-cake). In general, the symbolic nature of language flexibility: a word can be attached to a child’s word (e.g., Volterra, 1988), as a gesture, and its meaning may be extended by the interaction of the communication partners produce.

Note that these criteria are less stringent than those that have been applied to adult children (e.g., Volterra, 1988), which require a gesture to be contextually relevant to the actual act (e.g., “Give” or “Gimmie,” a pointing handshape held away from the viewer to represent an object; see Goldin-Meadow 1992). In a non-linguistic context, the meaning of the gesture was directed with the action of the hand, or the gesture was considered a pointing gesture (Meadow & Mylander 1984).

2.3 Coding the relationship

Gestures produced with speech were identified if combined with speech were identified if combined with speech. When a combined with speech gesture had a semantic relationship with the act of speech, the gesture was considered to be a gesture (cf. Masur 1983).

In general, the
2.3 Coding the relationship between gesture and speech

Gestures produced without speech and vocalizations produced without gesture were identified and categorized as either a gesture or a vocalization, depending on which movement or vocalization was combined. In this sense, a gesture with a meaning was divided into two types: those in which gesture was combined with speech (e.g., gestures combined with meaningful vocalizations). Following these criteria, it was decided that gestures and gestures combined with meaningful vocalizations were assigned to the category of 'speech-gesture combinations.'

The form of each gesture was described in terms of shape, size, and duration of movement, and the place of origin of the gesture. The gesture was divided into two parts: the referent (i.e., the object or part of the body that is the target of the gesture) and the action or attribute depicted by the motion or handling of the referent. The gestures were assigned to the appropriate categories according to their characteristics: Pointing hand held at the nose and arm raised upward after pointing to an object, or giving a book, were assigned to the category of 'speech-gesture combinations.'

Note that this was not an imitation of the communication partner's gesture, but rather a gesturing produced by the child in interaction with the partner. This criterion was not applied to gestures that were not considered to be communicative, such as gestures that were performed as an object or event (e.g., using a stick to hit another child). Instead, these gestures were assigned to a particular category based on their function as either an object or event (e.g., using a stick to hit another child). This criterion was used to identify gestures that were not considered to be communicative.
McNeill (1992) and Kendon (1972, 1980), gesture–speech combinations were considered synchronous if the vocalization occurred on the stroke of the gesture or at the peak of the gesture (the farthest extension before the hand began to retract).

2.4 Coding reliability

Reliability between two independent coders was assessed on a subset of the videotaped sessions. Reliability was 92% agreement between the two coders (N = 142) for isolating and identifying an utterance, 95% (N = 120) for classifying these utterances as speech alone, gesture alone, or gesture and speech in combination, 96% (N = 98) for dividing speech into meaningless and meaningful vocalizations and for assigning particular meanings to the meaningful vocalizations, 96% (N = 49) for assigning meanings to the gestures, 84% (N = 45) for coding the semantic relationship between gesture and the meaningful vocalization it accompanied, and 100% (N = 32) for coding the timing between the gesture and vocalization in a gesture–speech combination.

3 Results

3.1 Characteristics of the children’s speech

Table 12.1 presents the age at which each child first produced a meaningful vocalization (with or without a gesture) on our videotapes, and the age at which the child first produced a two-word combination on the videotapes. Note that since our videotaped sessions necessarily represent a small sample of each child’s communications, the onset ages listed in Table 12.1 may inflate the actual ages at which these children began producing meaningful words and two-word combinations. Four of the children (Beth, Emily, Nicholas, and Joseph) were already producing meaningful words during their first observation sessions; the remaining two (Ann and Christopher) were not and produced their first meaningful words on the videotapes at ages 16.5 and 13 months, respectively. The ages at which the children began producing two-word combinations on our videotapes ranged from 18 to 26.5 months, an age span that falls within the range typically reported for the onset of two-word speech (cf. Bloom & Caputides 1987; Bowerman 1973; Braine 1976).

3.2 Gesture production during the one-word period

Figure 12.1 presents the number of communicative symbolic gestures each of the six children produced, expressed as a proportion of the total number
When hand and mouth come together

![Graphs showing proportion of communications with gesture over age for different children.](image)

Figure 12.1. Proportion of gesture in each child's communications. The figure displays the number of communications containing gesture as a proportion of the total number of communications that the child produced at each session. Note that, for each child, the proportion of communications containing gesture remains relatively stable over time.

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gesture–speech combinations occurred on the stroke of the farthest extension before the

was assessed on a subset of the data between the two coders. To determine, 95% (N = 120) for class-gesture alone, or gesture and speech. The child's ability to mean speech into meaningless particular meanings to the assigning meanings to the gestures. The relationship between gesture-anied, and 100% (N = 32) for localization in a gesture–speech

child first produced a meaningful word. Our videotapes, and the age at which children began producing meaningful words. Four of the children (Beth, producing meaningful words. The remaining two (Ann and Christopher) first meaningful words on the videotapes. The ages at which the children's productions were captured within the range typically used in the research (cf. Bloom & Capatides

ord period

active symbolic gestures each proportion of the total number
of communications (speech and/or gesture) the child produced at each observation session. There were some individual differences across children in the level of gesture production. Five of the children produced gestures in approximately 20% of their communications, while the sixth child, Ann, produced gestures in approximately 40% of her communications across the observational period. However, for each child, the proportion of gesture produced was relatively stable over the period of observations.

3.3 Is gesture produced without speech during the one-word period?

One of the characteristics of adult gesture that lead McNeill (1992) to suggest that gesture and speech form an integrated system is the fact that gesture is rarely produced on its own without speech. Approximately 10 percent of the gestures adults produce occur without speech. We first ask whether the children in our study looked like adults in this regard, or whether their gestures frequently occurred on their own without speech.

Figure 12.2 presents the number of gestures produced without speech as a proportion of the total number of gestures the child produced at each observation session. Five of the six children produced a large proportion of gestures without speech during their initial observation sessions. Of Ann’s gestures (N = 34), 0.97 were produced without speech during her first observation session, as were 0.80 of Beth’s (N = 38); these two children were seen once every two months, and at their second sessions, the majority of their gestures were produced with speech. The decline in production of gesture without speech was also evident in the children observed at shorter intervals. Emily produced 0.60 of her gestures (N = 27) without speech during her first two observation sessions and then slowly began producing more and more gestures with speech. Joseph produced from 0.60 to 0.90 of his gestures without speech during his first three sessions (N = 39) and then began to consistently produce more gestures with speech. Christopher exhibited a more erratic pattern, producing approximately 0.70 of his gestures without speech during his first two sessions (N = 41) but not showing a consistent decline in gesture without speech until the sixth observation session. The final child, Nicholas, produced a relatively small proportion of gestures without speech (0.30) at his first observation session (N = 54) and continued to do so throughout the study.

Thus, while the proportion of communications containing gesture remained relatively stable over development (cf. Figure 12.1), the way in which the children used gesture during this time period (Figure 12.2) did not. Five children began the period producing gestures without speech. By the end of the one-word period, when the child used gesture it was primarily used in combination with speech. The sixth child, Nicholas, was produc-
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child, Nicholas, was produc-

Figure 12.2. Proportion of communications containing gesture alone. The
number of communications containing gesture without speech is shown
as a proportion of the total number of communications containing
gesture (i.e., gesture with or without speech) that each child produced.
Note that the proportion of gesture-alone communications decreased
over time for five of the six children (the sixth child, Nicholas, produced
very few gesture-alone communications from the beginning of the study).
ing a large proportion of gestures with speech at the start of our study. We speculate, though of course we cannot be certain, that he had already shifted to an integrated gesture–speech system before our first videotaping session at 15.5 months. One obvious implication of these data is that there appears to be a time early in the one-word period when communicative gesture is not yet fully integrated with speech. We now turn to the characteristics of the integration process.

3.4 When gesture is combined with speech, is it synchronous with that speech?

McNeill (1992) noted that one characteristic of gesture–speech integration in adults is the fact that gesture is synchronously timed with respect to the speech it accompanies. We asked whether the children in our study, when they produced their first gesture–speech combinations, timed those gestures in a synchronous fashion with respect to speech.

Figure 12.3 presents the proportion of gesture–speech combinations that were synchronous (i.e., the stroke of the gesture co-occurred with the speech) at each observation session for the six children. The proportions in Figure 12.3 included all gesture–speech combinations, even those in which gesture was combined with a meaningless (as opposed to a meaningful) vocalization. Five of the six children initially produced gesture–speech combinations in which gesture was not synchronous with speech. The sixth child, again Nicholas, produced gesture–speech combinations that were synchronously timed throughout the period when he was observed. The fact that most of the children experienced a period when their gestures were not synchronized with the speech they accompanied further suggests that gesture and speech do not form a completely integrated system from the start but may require some time to become aligned with one another.

3.5 When gesture is combined with speech, is it semantically coherent with that speech?

The final piece of evidence suggesting that gesture and speech form an integrated system in adults (McNeill 1992) is the fact that gesture is semantically coherent with respect to the speech it accompanies. Although gesture does not always convey precisely the same information as does speech, the information conveyed by gesture tends to be related in some way to the information conveyed by speech—the two “cover the same idea unit” (McNeill 1992: 27), thus creating semantic coherence across the modalities. We therefore explore the onset and developmental trajectory of communicative symbolic gesture combined with meaningful words.
ch at the start of our study. We are certain, that he had already seen before our first videotaping of these data is that there was a period when communicative behavior is synchronous with that of gesture–speech integration. This was observed in the children in our study, when two combinations, timed those gestures. Gesture–speech combinations that gesture co-occurred with the children. The proportions in combinations, even those in which (as opposed to a meaningful) synchronously produced gesture–speech pattern with speech. The sixth speech combination that were d when he was observed. The period when their gestures were accompanied further suggests that they are integrated system from the start.

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Gesture and speech form an integrated system that gesture is semantically accompanied. Although gesture information as does speech, the be related in some way to the “cover the same idea unit” coherence across the modalities. Mental trajectory of communicating words.

Figure 12.3. Timing in gesture–speech combinations. The figure displays the number of synchronous gesture–speech combinations as a proportion of the total number of gesture–speech combinations that the child produced at each session (the total includes gesture combined with meaningless vocalizations as well as meaningful vocalizations). Note that the proportion of synchronous combinations increased over time for all of the children except Nicholas, whose combinations tended to be synchronous from the start.
Figure 12.4 presents the number of gestures combined with meaningful speech as a proportion of all gesture–speech combinations produced by the six children at each observation session. Gesture-plus-meaningful-word combinations increased during this period in each of the six children. All of the children produced combinations in which gesture conveyed the same information as speech (e.g., point at box + “Box”), as well as combinations in which gesture conveyed different, but related, information from speech (e.g., point at box + “Open”). Note that in this second type of combination, the child is conveying two elements of a single proposition, albeit across two modalities. Thus, the ability to combine gesture and meaningful speech in a single utterance greatly expands the child’s communicative range.

It is important to note that the relatively late onset of communicative symbolic gesture combined with meaningful speech is not due to the absence of meaningful words in the child’s repertoires. All of the children except Ann and Christopher were producing meaningful words during session 1, and even Christopher produced his first meaningful words during session 2, one session prior to his first gesture-plus-meaningful-word combination.

3.6 The convergence point: when gesture and speech come together

More interesting than the fact that gesture-plus-meaningful-word combinations increase over time is the developmental moment at which these combinations first appear. Figure 12.5 presents three pieces of data superimposed on a single graph: (1) the proportion of gesture-alone communications, which declines over time; (2) the proportion of synchronized gesture–speech combinations, which increases over time; and (3) the onset of combinations containing gesture plus meaningful words, shown as a vertical line on each graph. Note that, for each of the five children who began to produce gesture-plus-meaningful-word combinations during our observation sessions, the three events converge: gesture-alone combinations began to decline and synchronous gesture–speech combinations began to increase at just the moment when gesture was first combined in the same utterance with a meaningful word (the sixth child, Nicholas, had presumably gone through this convergence point prior to our observations). Thus, the age at which each of the children began to produce communicative gestures in combination with meaningful words was precisely the age when timing began to improve dramatically in each child’s gesture–speech combinations.

Note that in Figure 12.5 the measures of synchronization prior to the onset of gesture combined with meaningful speech (i.e., left of the vertical line) are based only on combinations of gesture with meaningless vocaliza-

Figure 12.4. Onset figure displays the meaningful words as a proportion of those containing each session.
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Gesture-plus-meaningful-word in each of the six children. All of
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repertoires. All of the children meaning meaningful words during
first meaningful words during
ure-plus-meaningful-word combi-

and speech come together

e-plus-meaningful-word combi-
mental moment at which these
ents three pieces of data super-
proportion of synchronized uses over time; and (3) the onset
meaningful words, shown as a ver-
 of the five children who began
ations during our obser-
me-alone combinations
 combine to
was first combined in the same
child, Nicholas, had presum-
rior to our observations). Thus,
produce communicative ges-
was precisely the age when
child’s gesture–speech combi-

of synchronization prior to the 1 speech (i.e., left of the vertical

Figure 12.4. Onset of gesture combined with meaningful words. The
figure displays the number of combinations containing gesture plus mean-
meaningful words as a proportion of all gesture–speech combinations (including
those containing meaningless vocalizations) that the child produced at
each session.
When hand and motions, since, by definition, deduced at that point. In cot and beyond (i.e., to the gesture with either meaningful to note that, after speech, the proportion of combinations of gesture with motions of gesture with meta 0.91 vs. 0.89; Beth 0.80 vs. 0.86; Nicholas 0.86 vs. 0.8 an increase in synchrony vocalizations over this time children's first gesture-plu

Thus, the two character adult speakers – temporally absent at the onset of one-word period. When careful words, they also begin speech (both meaningful and meaningful)

In sum, we have observed there is a period when the gesture is relatively combined with speech, that is accompanied by gestural integration – the child meaningful words and to synchronize meaningful speech and the to mark the beginning of

4 Discussion

This study explored the gesture and speech in your development. Our finding produce communicative; most of the communicative our study were unaccompanied or not. Moreover, during independent of speech, their gestures with speech
When hand and mouth come together

tions, since, by definition, this is the only type of combination the child produced at that point. In contrast, the synchronization measures at this point and beyond (i.e., to the right of the line) are based on combinations of gesture with either meaningful or meaningless speech. It is therefore important to note that, after gesture began to be combined with meaningful speech, the proportion of synchronous combinations was the same in combinations of gesture with meaningful words for each of the six children (Ann 0.91 vs. 0.89; Beth 0.80 vs. 0.84; Emily 0.79 vs. 0.89; Christopher 0.83 vs. 0.86; Nicholas 0.86 vs. 0.89; Joseph 0.93 vs. 0.98). In other words, there was an increase in synchrony in combinations of gesture plus meaningless vocalizations over this time period — an increase that coincided with the children’s first gesture-plus-meaningful-word combinations.

Thus, the two characteristics that define gesture—speech integration in adult speakers — temporal synchrony and semantic coherence — appear to be absent at the onset of one-word speech and converge later during the one-word period. When children begin to combine gestures with meaningful words, they also begin to synchronize their gestures with respect to speech (both meaningful and meaningless vocalizations).

In sum, we have observed the following developmental sequence. First, there is a period when the child produces communicative symbolic gestures that function relatively independently of speech. During this period, gesture is frequently produced without speech, and, even when it is combined with speech, that speech is meaningless and not synchronized with the accompanying gesture. Next, gesture and speech become more fully integrated — the child begins to produce gesture in combination with meaningful words and to synchronize gesture in relation to speech (both meaningful and meaningless speech). Thus, the combination of gesture and meaningful speech and the synchronization of gesture with speech appear to mark the beginning of gesture—speech integration.

4 Discussion

This study explored the relationship between communicative symbolic gesture and speech in young children at the beginning stages of language development. Our findings suggest that there is a period when children produce communicative symbolic gestures independent of speech. Initially, most of the communicative symbolic gestures produced by the children in our study were unaccompanied by speech sounds of any sort (meaningful or not). Moreover, during this period (when gesture appeared to be operating independently of speech), even for the few times children combined their gestures with speech sounds, the gestures were not synchronous with
those sounds and the sounds themselves were not meaningful. It was not until the children began combining gesture with meaningful words that gesture became appropriately timed with respect to speech. Note that the children had been producing meaningful words on their own (i.e., without gesture) for some time. Thus, the novel ability here is the ability to combine gesture with meaningful words, rather than the ability to produce meaningful words or meaningful gestures per se.

It is possible that the convergence we see across gesture and speech during the one-word period reflects a newly developed motoric skill in the child, one that allows hand and mouth to work together. If so, what is impressive is that this putative skill, which results in synchrony across the two modalities, is temporally linked to changes in the semantic system. For the first time, the child is able to convey meaningful information in two distinct modalities within a single communicative act. This finding reinforces the premises of McNeill’s (1992) view of gesture–speech integration – that gesture and speech come together to form an integrated system both in terms of temporal synchrony and in terms of semantic coherence. Both are central to establishing a unified gesture–speech system.

Further evidence that the relationship between communicative symbolic gesture and speech changes during the early stages of language development comes from an experimental study conducted by Bates, Thal, Whitesell, Fenson & Oakes (1989). Bates et al. modeled gestures for 13- to 15-month-olds and varied the words that accompanied each gesture. They found that the children in an early period of lexical development imitated the modeled gestures at the same rate regardless of the speech that accompanied those gestures. In other words, their performance on a gesture was unaffected by the type of speech with which that gesture occurred, suggesting that these children had not yet unified gesture and speech into a single system. In contrast, the children in later stages of lexical development imitated gestures at different rates, depending upon the words that accompanied the gestures. These children did not treat gesture and speech as independent sources but rather unified the two into a single message – as would be expected if they had already begun to integrate gesture and speech into a single system.

The Bates et al. (1989) study underscores two important points. First, the findings confirm that there is a point early in development when communicative symbolic gesture and speech do not yet form a fully integrated system. Second, the findings make it clear that the integration seen across modalities is not limited to production but is evident in comprehension as well (see Morford & Goldin-Meadow 1992, who also found evidence for gesture–speech integration in comprehension in one-word speakers).

In their studies of gesture and language in 9- to 13-month-olds, Bates et al. (1979) found a correlat age several months prior to the speech become integrated the later ages. It is impor related with later word use ability) and still not be inte term. Indeed, Bates et al. found between gesture and an underlying capacity for

Bringing together gestu allows the child to produc together to produce a sin, ducted on these same six c that the integration ofgesture combination – combinat related) information from giration (but not before), et following type: gesture co at a box), and speech conv modalities conveyed a sin, one child produced a fall and said, “Mouse,” thus the proposition he inte gesture + speech combina even a conceptual, breakt least is made evident, and gesture and speech.

The appearance of the turn, heralded the onset o relation between the onse conveyed different inform was high ($r = .90$) and rel Thus, the children who we and speech conveyed diff also first to produce two-expect a child who can co modalities to be closer to ments within a single spo has not yet demonstrated single communicative act firms this intuition and m nate elements of a propos.
were not meaningful. It was not true with meaningful words that respect to speech. Note that the words on their own (i.e., without similarity here is the ability to combine the ability to produce meaningfulness across gesture and speech only developed motoric skill in the to work together. If so, what is the resulting in synchrony across the unities in the semantic system. For meaningful information in two disative acts. This finding reinforces gesture–speech integration – that in an integrated system both in terms of semantic coherence. Both are speech system.

between communicative symbolic early stages of language develop- ing conducted by Bates, Thal, et al. modeled gestures for 13- to accompanied each gesture. They found lexical development imitated regardless of the speech that accompanied performance on a gesture was that gesture occurred, suggesting gesture and speech into a single ages of lexical development imitating upon the words that accompa- ny gesture and speech as one two into a single message – as begun to integrate gesture and

three important points. First, the in development when com- not yet form a fully integrated that the integration seen across is evident in comprehension as is also evident in one-word speakers). In 9- to 13-month-olds, Bates et

al. (1979) found a correlation between gesture production at 9 months (an age several months prior to the age at which we have found that gesture and speech become integrated into a single system) and word comprehension at the later ages. It is important to point out that early gesture use can be correlated with later word use (both reflecting a shared underlying cognitive ability) and still not be integrated with speech in the sense that we use the term. Indeed, Bates et al. (1979: 128) argue that the correlation they have found between gesture and speech reflects just such an ability, in particular an underlying capacity for communication via conventional signals.

Bringing together gesture and speech into a single well-integrated system allows the child to produce utterances in which words and gestures work together to produce a single message. Indeed, in additional analyses conducted on these same six children, Goldin-Meadow & Butcher (n.d.) found that the integration of gesture and speech set the stage for a novel type of combination – combinations in which gesture conveyed different (but related) information from that conveyed in speech. For example, after integration (but not before), each of the children produced combinations of the following type: gesture conveyed the object of a desired action (e.g., point at a box), and speech conveyed the action itself (“Open”); together, the two modalities conveyed a single proposition (open box). As another example, one child produced a FALL DOWN gesture (a palm flipping over in the air) and said, “Mouse,” thus describing both the action and the actor of the proposition he intended to communicate. These new types of gesture + speech combinations represent a communicative, and perhaps even a conceptual, breakthrough for the child – a breakthrough that at the least is made evident, and might even be facilitated, by the integration of gesture and speech.

The appearance of these new types of gesture–speech combinations, in turn, heralded the onset of two-word speech. In these six children, the correlation between the onset of combinations in which gesture and speech conveyed different information and the onset of two-word combinations was high \( r = .90 \) and reliable \( p < .05 \); Goldin-Meadow & Butcher n.d.). Thus, the children who were first to produce combinations in which gesture and speech conveyed different, yet conceptually related, information were also first to produce two-word combinations. It makes intuitive sense to expect a child who can convey two elements of a single proposition across modalities to be closer to developing the ability to produce those two elements within a single spoken utterance – certainly closer than a child who has not yet demonstrated the ability to produce those two elements within a single communicative act in any form at all. The positive correlation confirms this intuition and makes it clear that the cognitive ability to concatenate elements of a proposition within a single communicative act, although
necessary, is not sufficient to guarantee two-word speech—all of the children we have observed thus far were able to concatenate elements of a proposition across gesture and speech at a time when they were unable to accomplish this feat in speech alone.

We have shown that when, early in development, children use communicative symbolic gesture, they use it relatively independently of speech. In other words, gesture does not form a fully integrated system with speech from the outset. At some point during the one-word period, children begin to combine their communicative symbolic gestures with meaningful speech and at the same moment produce those gestures in temporal synchrony with that speech. We take the convergence of the semantic union and the temporal union of the two modalities to be the beginning of gesture–speech integration in the young child. This integration sets the stage for the onset of gesture–speech combinations in which gesture conveys different (but related) information from the information that is conveyed in speech. These combinations, in turn, herald the onset of two-word speech. Thus, gesture provides the child with an important vehicle for information that is not yet expressed in speech, and, as such, it provides the listener (as well as the experimenter) with a unique window into the child’s mind.

NOTES

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1 Two of the subjects in this study, Ann and Beth, were described by Goldin-Meadow & Morford (1985). The current study differs from the previous account in that additional videotapes were included in the data set and a variety of new analyses were performed on that entire set.

2 The gestures Bates et al. (1989) modeled for the children in their study were different from the gestures we observed in our study in that they were performed with objects. For example, for the phone gesture, a block was held to the ear as if it were a receiver. Although these gestures were not ‘empty-handed’, which was a requirement for a gesture in our study (cf. Petitto 1988), all of the actions were performed on blocks of different sizes, shapes, and colors and thus could not have been functional acts. In this sense, the gestures used in the Bates et al. study were comparable to the behaviors we took to be gestures in our study.

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