

## Gesture and Early Bilingual Development

Elena Nicoladis, Rachel I. Mayberry, and Fred Genesee  
McGill University

The relationship between speech and gestural proficiency was investigated longitudinally (from 2 years to 3 years 6 months, at 6-month intervals) in 5 French–English bilingual boys with varying proficiency in their 2 languages. Because of their different levels of proficiency in the 2 languages at the same age, these children's data were used to examine the relative contribution of language and cognitive development to gestural development. In terms of rate of gesture production, rate of gesture production with speech, and meaning of gesture and speech, the children used gestures much like adults from 2 years on. In contrast, the use of iconic and beat gestures showed differential development in the children's 2 languages as a function of mean length of utterance. These data suggest that the development of these kinds of gestures may be more closely linked to language development than other kinds (such as points). Reasons why this might be so are discussed.

Adults gesture while they speak to such a large extent that some investigators have proposed that the spoken language system should be renamed the "speech–gesture system" (McNeill, 1992; Riseborough, 1982). Although gesture production is highly characteristic of the language spoken by adults, its developmental relationship to speech at the beginning stages of language development is not completely understood. The purpose of the present study is to shed light on the nature of the relationship between children's early use of gesture and their spoken language development to better understand the nature of the speech–gesture system across the life span.

Very young children can communicate by using their hands and arms before they can speak (Petitto, 1988, 1992; Zinober & Martlew, 1985a). As early as 9 months of age, children perform actions on objects for communicative purposes, such as showing and giving objects, as well as pointing to objects and people (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979; Bates, Camaioni, & Volterra, 1975). These communicative actions on objects share some important features with early spoken words, especially the feature of representing meaning for the purpose of intentional communication (Acredolo & Goodwyn, 1985; Bates,

Bretherton, Shore, & McNew, 1983; Bates, Thal, Whitesell, Fenson, & Oakes, 1989).

Children's early actions on objects for communicative purposes eventually become decontextualized and refer to stable meanings across contexts (Caselli, 1990). These early, decontextualized gestures have been found to convey the same range and kind of meanings as early spoken words as, for example, in crossing the hands and waving the fingers to mean *butterfly* (Acredolo & Goodwyn, 1985). Between 11 and 20 months, children have been observed to use either a gesture or a spoken word to refer to an object but not to use both (Acredolo & Goodwyn, 1988). Some children have been observed to use more gestures than spoken words at this early stage of communicative development (Iverson, Capirci, & Caselli, 1994). These early gestures are often produced without speech, and when they are, are not always timed with it (Butcher & Goldin-Meadow, in press).

The developmental trajectory of early gesture in relation to early spoken language development beyond the one-word stage is only partially understood. Some investigators have proposed that normally developing children abandon gestures after 20 months, although there is little data available on children's gestures beyond this age. The hypothesis is that spoken words eventually replace gestures; once spoken words are acquired, there is no longer any need for gestures (Zinober & Martlew, 1985a, 1985b). For example, gestures with a specific referent have been observed to disappear once children know a spoken word for that referent (Acredolo & Goodwyn, 1988; Carter, 1975). A decrease in gesture has also been reported to occur for specific kinds of gestures, namely, gestures referring to routines and games (Caselli, 1990), deictic gestures in spontaneous play (Zinober & Martlew, 1985b), and symbolic gestures (Acredolo & Goodwyn, 1988).

Although some studies have noted a decrease in young children's use of gesture as spoken language develops, other studies suggest that decontextualized gesture becomes linked to language once the child begins to speak. Between 10 and 20 months, gestures have been observed to occur more frequently with speech, become timed with speech, and convey information complementary to the co-occurring speech message (Morford & Goldin-Meadow, 1992; Zinober & Martlew, 1985a). An increase in the

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Elena Nicoladis and Fred Genesee, Department of Psychology, McGill University, Montreal, Quebec, Canada; Rachel I. Mayberry, School of Communication Sciences and Disorders, McGill University, Montreal, Quebec, Canada.

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Correspondence concerning this article should be addressed to Elena Nicoladis, who is now at the Department of Linguistics, University of Alberta, Assiniboia Hall, Edmonton, Alberta, Canada T6G 2E7.

propositional use of gestures in conjunction with speech has also been observed. For example, the child would combine a gesture and a word into one proposition, as in gesturing "give" near a ball and saying the word *ball*. In this example, the gesture denotes the request "give-me" and speech denotes the object to be given. The age of onset of gesture + word utterances has been found to correlate with the onset of two-word speech (Butcher & Goldin-Meadow, in press; Goldin-Meadow, 1998; Morford & Goldin-Meadow, 1992). Between 16 and 20 months, gesture + speech expressions have been observed to increase significantly in Italian children, with the most frequently joined elements being gesture + word combinations (primarily a deictic gesture and a content word) and word + word combinations (Capirci, Iverson, Pizzuto, & Volterra, 1996). Combinations of two gestural elements were infrequent, and no combinations of two representational gestures were observed.

Thus, the available research shows that for children between 9 and 26 months, gesture both precedes and complements early spoken language at the one- and two-word stages of development. How gesture develops between 2 and 3 years of age in relation to language development is currently unknown. Moreover, whether gesture development is paced by linguistic development or, alternatively, is paced by cognitive development occurring in parallel to language is currently unknown. Studies of children acquiring a single language cannot address this important question because it is impossible to separate cognitive development from language development in these circumstances. In the present study, we turn to young children who are acquiring two languages simultaneously from birth to investigate the nature of gesture development in relation to language development between the ages of 2 and 3½ years.

Contrary to popular belief, bilingual children, who are acquiring two languages simultaneously from birth, often show unequal development in their two languages with one language being more advanced as compared with the other. Although occasional instances of balanced bilingualism have been observed in young children (e.g., Saunders, 1988), these instances are sometimes of brief duration (e.g., Leopold, 1949). Children who are raised speaking two languages often show an imbalance in their proficiency of their two languages (Genesee, Nicoladis, & Paradis, 1995; Grosjean, 1982; Leopold, 1949; Meisel, 1989; see also Nicoladis & Genesee, 1997). More advanced development in one language, or language dominance, is typically the case in bilingual children primarily owing to the child having more exposure to one language as compared with the other as in, for example, spending more time with the mother and using her language more often as compared with time spent with the father and using his language, although other factors can be involved as well (de Houwer, 1990; Saunders, 1988). Therefore, the unequal development of two languages in one child provides an ideal means of separating cognitive from linguistic factors in investigating the underlying nature of gesture development. If gesture development is primarily paced by cognitive factors, then bilingual children would be expected to show equivalent gesture production when speaking the two languages, even if one was more developed than the other. Alternatively, if gestural development is primarily paced by linguistic factors, then bilingual children would be expected to show non-equivalent gesture production when speaking the more developed language as compared with the less developed one. Recent re-

search demonstrating that gesture production is highly contingent on the production of spoken language in adults strongly hints that the latter hypothesis will hold (Mayberry & Jaques, in press; Mayberry, Jaques, & DeDe, 1998; McNeill, 1992).

An important question for the present study is how gesture should be defined for measurement. The available studies on early gesture development vary considerably with respect to which nonspeech, communicative behaviors were categorized as gesture and, within this definition, what subtypes of gesture were identified (Erting & Volterra, 1990). For example, Zinober and Martlew (1985a, 1985b) categorized gestures largely (but not exclusively) by their pragmatic function; other researchers have categorized gestures by their form (e.g., open-handed reaching; Masur, 1983) or by their relationship to the object to be symbolized, regardless of whether the object is in the hand or not (e.g., symbolic gestures; Bates et al., 1989; Capirci et al., 1996; Iverson et al., 1994). Other researchers have required that gestures be "empty-handed" to distinguish early symbolic play from the manual gestures used by adults (e.g., Acredolo & Goodwyn, 1985, 1988; Goldin-Meadow & Morford, 1985; Morford & Goldin-Meadow, 1992).

Unlike the literature on young children's gesture, there is greater definitional uniformity in the literature on adult's gesture. To maintain continuity with this body of research, we used the adult definition of gesture, namely, empty-handed hand and arm movements used for intentional communication. Hand and arm movements that served to act on objects or adjust the body were not considered to be gesture (Ekman & Friesen, 1969; Kendon, 1980; McNeill, 1992).

In the present study, we investigated the relationship between gesture and language development in children acquiring two languages simultaneously from birth between the ages of 2 years 0 months and 3 years 6 months. We used the technique of obtaining spontaneous language samples at regular intervals to investigate several aspects of the bilingual children's gesture and language development. First, we measured and described the children's language development in each of their two languages as a function of age. Second, we described and noted the extent to which the children produced gestures when speaking each of their two languages as a function of age. Third, we investigated in detail the relationship between the children's gesture production and their language development in each of their two languages to shed light on the underlying nature of gesture development and answer the following question: Is the child's early use of gesture linked to a general cognitive capacity that develops before and separately from an emerging linguistic capacity, or, alternatively, is the child's early use of gesture deeply linked to an emerging linguistic capacity?

## Method

### *Participants*

The data used in this study were originally collected for a study on language differentiation in early bilingual development (see Genesee et al., 1995; Nicoladis & Genesee, 1996). Five boys who were being raised in bilingual families in Montreal, Quebec, Canada, were included in this study; all were observed from the ages of 2 years 0 months to 3 years 6 months. Although five is a small number of participants, these children are unique in that all had been exposed to French and English since birth, one language primarily from each parent. The children are identified here by a

three-letter code related to their names (Mat, Nic, Oli, Ste, and Yan). All the children except Yan were learning French from their fathers and English from their mothers. Yan's mother spoke primarily French and his father spoke primarily English. All of the children were firstborn and had no siblings at the beginning of the study. Mat and Oli's families had additional children during the course of the study. All parents had completed high school, and two parents had a university degree. Four of the fathers worked full time outside the home at blue-collar or managerial jobs. Four of the mothers worked part time outside the home in clerical or teaching positions. Both parents of 1 child were on welfare. Two children were in day care full time: Oli attended a French day care, and Yan attended a bilingual day care at age 2 years and 2 years 6 months and a French day care at age 3 years and 3 years 6 months.

### Procedure

The data reported here come from videotaped sessions taken every 6 months, starting when the children were about 2 years and continuing until they were about 3 years 6 months. The exact ages of the children at each observation session are given in the Appendix. To sample both the children's languages, a bilingual observer videotaped the children in separate sessions at each sampling period, one session with each parent. The sessions with each parent at every sampling period were as close together as possible and generally no more than 10 days apart. There were, however, some exceptions to this rule: Yan at 3 years and Mat at 3 years 6 months. For Yan, a mechanical malfunction caused the loss of the videotape of the observation session with his mother that had been filmed at about the same time as the session with his father. So, an earlier observation session with his mother was used. For Mat, the parents' schedule did not permit filming sessions closer together at that time. In both cases, the children's language input did not change noticeably from the first filming session to the second, so their relative proficiency in each language probably did not change.

In all sessions, the parents were asked to play as they normally would with their child. The videotaped sessions covered a variety of contexts from book reading to playing in the sandbox to eating a meal. Each session lasted between 45 and 60 min. The primary activity that occupied the child during each session is given in the Appendix.

### Transcription and Coding

Using the CHAT system (MacWhinney, 1995), the observer who attended the sessions (E.N.) transcribed the first 20 min after the first 5 min of each session. The CHAT system uses the utterance as the basic unit. Each utterance was coded for spoken language. The children's gestures were also coded.

*Spoken language transcription and coding.* The children's utterances were classified into five different language categories: (a) French only, (b) English only, (c) mixed, (d) either language, and (e) unintelligible. French-only and English-only utterances consisted solely of words belonging to standard Quebec French or English, respectively. Mixed utterances contained words from both French and English. Either-language utterances contained only words common to both French and English (i.e., interjections or proper nouns or both that could be either French or English; see Nicoladis, 1995, for a complete list of these words). Unintelligible utterances could be phonetically transcribed but could not be assigned a language category (e.g., babbling or idiosyncratic vocalization). Unless noted otherwise, the analyses concern only children's utterances in French only or English only; thus the mixed-language, either-language, and unintelligible utterances were excluded from the analyses. The mixed-language utterances were excluded because of the theoretical difficulties in calculating our primary measure of children's language development, mean length of utterance (MLU).

*Gesture transcription and coding.* The children's gestures were transcribed following transcription conventions developed for gesture research

with adults. Therefore, only empty-handed gestures in which an object did not play an integral part were examined. It is clear that many hand movements with objects (e.g., a child holding a toy airplane raises it in the air and says "up") have symbolic and communicative functions (Bates et al., 1983). However, it is unclear how such actions are related to the gestures used by adults when speaking. In this study, gestures that included objects as an integral part were excluded because these were often difficult to distinguish from actions on objects (see also Acredolo & Goodwyn, 1985; Butcher & Goldin-Meadow, in press, for similar arguments). If, however, a child happened to be holding an object while gesturing (e.g., a child holding a toy airplane points at the family dog and says "dog"), the gesture was included in the analysis. This definition of gesture is in keeping with that used in investigations of adults' gesture (McNeill, 1992) and thus maintains a continuity with this body of research to help elucidate the degree to which children's early gestures are similar to and different from that of adults.

Gesture was coded as being produced with or without spoken language and, if so, whether the language was French or English. Next, the children's gestures were coded for type of gesture following the categories used in research with adult subjects: (a) emblems, (b) deictics, (c) iconics, and (d) beats (Ekman & Friesen, 1969; Kendon, 1980; McNeill, 1992). Emblems were conventional gestures, the meaning of which is recognized by adults without accompanying speech. Included in this category were gestures taught to children as part of social routines and games, such as waving *bye-bye* or holding up one index finger to indicate *one*. Deictic gestures consisted of pointing at a person or an object; abstract pointing was not observed in these children. Iconic gestures represented the action or shape of the object, such as flapping hands to indicate *bird*. Beats were meaningless, biphasic, up-down movements of the hands and arms that had an emphatic function, such as making a beat in the air with the hand while saying "No go bed." A fifth category not used in research on adult gesture was taken from research on children's early gesture; *give* gestures were empty-handed, palm-up gestures and could occur either with the fingers curling back and forth or still. Prelinguistic children have often been observed to use these empty-handed gestures as requests (Bates et al., 1979; Iverson et al., 1994).

Finally, the probable meaning of each gesture in relation to the accompanying spoken language was coded. In almost all instances, the children's gestures either provided the same information or could be thought to be related propositionally to the corresponding speech. Thus, the coding scheme divided the children's gestures into those that provided the same information as the corresponding speech and those that provided different information. A gesture was coded as matching if the meaning of the gesture specified or was identical to the meaning of the speech. For example, if a child pointed to a ball and said "Ball," this gesture was coded as matching because it provided specifying information (i.e., pointing out which ball) relative to the speech. Similarly, if the child made an empty-handed throwing motion and said "Throw," the gesture provided identical information to the speech and was coded as matching. By contrast, a gesture was coded as nonmatching when the probable meaning of the gesture supplemented the word meaning to create a two-element proposition, or gesture + word utterance. For example, one child in this study pointed to a toy car and said "Brisé" (*broken*). The meaning of the gesture was thought to be *car* and hence supplemented rather than matched the meaning of the word.

*Reliability.* Twenty-nine out of the 40 total transcripts were checked for accuracy by a native speaker of Quebec French. The second rater checked the entire 20 min of each of these sessions. The interrater agreement for spoken-language transcription averaged 93%, ranging from 77% to 100%. The interrater agreement for language coding averaged 97%, ranging from 82% to 100%. Three randomly chosen transcripts were completely recoded for gesture by a second coder who was highly experienced in gesture and sign-language transcription. The interrater reliability was 97% for the presence of gesture. Of the agreed-upon gestures, the

interrater reliability for gesture type was 96% and 92%, respectively, for meaning and kind of information conveyed by gesture.

It should be noted that five instances of gestures that occurred with the children's French or English utterances were clearly gestures but did not readily belong to any of the categories for kinds of gestures that we had identified: three with Oli at 2 years and two with Yan at 2 years.<sup>1</sup> These gestures were included in analyses of gesture frequency but not gesture types used by the children in each language.

### Language Development Indexes

Indexes of spoken language development were the children's MLUs in French and English. MLU was calculated using both observation sessions at the same sampling age. The children's MLU was calculated over their use of productive morphemes in their French and English utterances. A morpheme was considered productive if it was used contrastively within an observation session or had been used contrastively in a previous observation session. This calculation means that French and English MLU may not be completely comparable because MLU is biased toward higher measures in French than English because French sentences require more morphemes than English sentences (Goodz, 1989).

### Results

The children's language development and gesture development were analyzed several different ways to investigate the nature of the relationship between the two. First, we analyzed the children's language development in their two languages. Second, we analyzed the degree to which the children produced gesture with and without speech, and, in the former case, we scrutinized the various types of gestures they produced with spoken language. Third, we analyzed the children's gesture development as a function of their development in each of their two languages.

### Spoken Language

*Utterance data.* During the six sampling sessions, the children produced 4,270 utterances in the French-only and English-only categories; of these, 1,923 were English and 2,327 were French. Although there were more tokens of French utterances across children, each child often produced more English utterances than French utterances. The number of utterances each child produced in English and French as a function of age is shown in Table 1. A two-way analysis of variance (ANOVA; Age  $\times$  Language) showed that the children were significantly more talkative as they got older, with a mean of 46 utterances at age 2 years 0 months, 92 utterances at age 2 years 6 months, 140 utterances at age 3 years 0 months, and 154 utterances at age 3 years 6 months,  $F(3, 32) = 3.28, p < .05$ . There were no significant differences in the number of utterances the children spoke in English or French, although there was considerable variation among individual children's use of the two languages (see Table 1).

*Language development.* Each child's MLU in English and French at each sampling age is shown in Table 1. The children's English MLU ranged from 1.06 at age 2 years 0 months to 3.24 at age 3 years 6 months. Their French MLU ranged from 1.00 at age 2 years 0 months to 3.15 at age 3 years 6 months. However, a comparison of each child's MLU in English and French at each age shows their bilingual development was often unequal, as is typically the case. For the group, mean English MLU was significantly higher than mean French MLU at age 3 years 6 months but

Table 1  
*Mean Length of Utterance (and Number of Utterances) in English and French as a Function of Age*

Child/language	2 years 0 months	2 years 6 months	3 years 0 months	3 years 6 months
Mat				
English	1.23 (118)	1.26 (171)	2.04 (265)	3.24 (335)
French	1.67 (57)	1.57 (44)	1.65 (58)	1.20 (4)
Nic				
English	1.30 (139)	1.59 (155)	2.01 (282)	2.58 (227)
French	1.00 (1)	1.00 (4)	1.25 (31)	1.13 (10)
Oli				
English	1.83 (48)	1.90 (33)	2.73 (227)	3.18 (141)
French	2.09 (78)	3.00 (290)	2.12 (257)	3.15 (147)
Ste				
English	1.06 (17)	1.29 (66)	1.19 (142)	1.75 (248)
French	1.00 (5)	1.04 (62)	1.08 (89)	1.59 (53)
Yan				
English	1.23 (88)	1.31 (117)	1.58 (198)	1.71 (24)
French	1.34 (50)	1.38 (95)	1.56 (208)	2.68 (404)

not at younger ages, paired  $t(9) = -2.02, p < .037$ . As previously described, MLU in French is biased toward higher levels because more morphemes are required in French sentences as compared with English ones. This fact adds support to the finding that several children were more advanced in English development as compared with French development. The children's unequal development of English and French is important for our later analyses of gesture development in relation to language development.

### Gesture Development

*Gesture and spoken language.* During the six sampling sessions, the children produced 1,905 total gesture tokens with a mean of 11.8 gestures at age 2 years 0 months, 27.8 gestures at age 2 years 6 months, 49.5 gestures at age 3 years 0 months, and 44.7 gestures at age 3 years 6 months. As Table 2 shows, the children primarily gestured while speaking. Only a small proportion of gestures was produced without spoken language throughout the age range studied. At age 2 years 0 months, 81% of gestures were

<sup>1</sup> The five gestures that could not be categorized were as follows: (a) Oli said "allo Jammy!" ("hello Jammy"), holding both hands over his head about shoulder-width apart, with a toy construction cone in each hand; (b) Oli said "allo Jammy!" ("hello Jammy"), holding both hands next to his eyes and pointing toward the observer (Elena Nicoladis), with a toy construction cone in each hand; (c) Oli did an exact repetition of b; (d) Yan said "fini" ("finished") with both hands touching together in front of his body as if he were praying; and (e) Yan said "down down" with both index fingers pointing up in front of his chest; first he bounced his index fingers apart and then back together again.

Table 2  
*Percentage (and Number) of Children's Gestures Occurring With No Speech  
 or With a Language Category*

Condition	2 years 0 months	2 years 6 months	3 years 0 months	3 years 6 months
Gestures with no speech	18.7 (51)	17.3 (70)	12.8 (89)	8.8 (47)
Language category				
French/English	41.1 (112)	65.9 (267)	71.4 (496)	83.1 (442)
Mixed utterance	0 (0)	3.0 (12)	3.7 (26)	4.5 (24)
Either language	24.5 (67)	7.9 (32)	6.5 (45)	2.4 (13)
Unintelligible speech	15.8 (43)	5.9 (24)	5.6 (39)	1.1 (6)

*Note.* Percentages were calculated out of the total number of gestures produced by all children at each age sampling. The *either language* category refers to an utterance that could be either French or English, such as "Mama"; a *mixed utterance* contained words from both French and English, such as "birdy là."

produced with spoken language and 91% of all gestures were produced with spoken language at age 3 years 6 months. These results show that young children's gesture production, like that of adults', is primarily associated with the act of speaking.

*Gestures in English and French.* The proportion of gestures the children produced with utterances in English or French increased from 41% at age 2 years 0 months to 83% at age 3 years 6 months (see Table 2). On average, independent of age, 25% of the children's English and French utterances were accompanied by gesture. The children produced 1,317 total gesture tokens with utterances that were entirely in French or English. A two-way ANOVA (Age  $\times$  Language) showed no significant differences in the frequency of gesture production with French or English utterances as a function of age,  $F(3, 32) = 0.336, p = .566, ns$ . Thus, the children were not prone to gesture more with one language as compared with the other.

*Gesture meaning.* Next we ascertained whether the children's gestures had similar meanings to those expressed in their utterances. Recall that gestures were coded as having two possible meaning relationships with the utterance, one that matched the corresponding spoken language and one that did not (i.e., provided supplemental meaning). The mean percentage of gestures that conveyed the same meaning as the corresponding speech was 49% at age 2 years 0 months, 68% at age 2 years 6 months, 68% at age 3 years 0 months, and 70% at 3 years 6 months. A one-way ANOVA revealed no significant difference in the correspondence between gesture and utterance meaning with age,  $F(3, 36) = 0.98, ns$ . Note that the variance here is so huge that age effects might be hard to identify in this data set. Until this effect has been examined in a large sample, we tentatively conclude that the gesture of young children, like that of adults, conveys meaning similar to that of the accompanying utterance. Next we examined the types of gestures the children produced while speaking English and French.

### *Gestures Produced With Language*

*Gesture tokens.* The children produced 747 gesture tokens with English utterances and 590 gesture tokens with French utterances, but these were unevenly distributed across the gesture types.

The proportional distribution of each child's gesture tokens as a function of gesture type is shown in Figures 1A through 1E for both English and French. Inspection of Figure 1 clearly shows that the most frequent type of gesture produced by all the children with English and French utterances was the point, followed by emblem and give gestures.

*Gesture types.* In Figure 1, we graphed the different gesture types as a percentage of the total number of gestures. Although iconic and beat gestures were produced infrequently, inspection of Figure 1 suggests a contingent pattern for these two gesture types as a function of language. No child produced a beat gesture in a given language without also having produced an iconic gesture in that same language. For example, Figures 1A and 1B show that Mat and Nic produced iconic and beat gestures with English utterances but no tokens of iconic and beat gestures with French utterances. Figure 1C shows that Oli produced iconic and beat gestures with French utterances and iconic and beat gestures with English utterances. Finally, Figures 1D and 1E show that Ste and Yan produced iconic gestures with French and with English utterances but no instances of beat gestures with French or English utterances.

*Gesture patterns and language.* This distributional analysis of the children's gesture production as a function of gesture type suggested that there might be a relationship between language development and the production of iconic and beat gestures with utterances in that particular language. As Figures 1A and 1B showed, Mat and Nic produced iconic and beat gestures with English utterances but not French utterances. Table 1 showed that their English development was in advance of their French development. Figures 1C and 1D showed that Oli and Ste produced iconic and beat gestures with English utterances and with French utterances, and Table 1 showed that their development in English and French was relatively balanced. Finally, Figure 1E showed that Yan produced iconic gestures with English utterances and with French utterances but no beat tokens in either language. Table 1 showed that his English and French development were relatively balanced but remained below an MLU of 3.0. Thus, these distributional analyses suggest that whereas gesture produc-

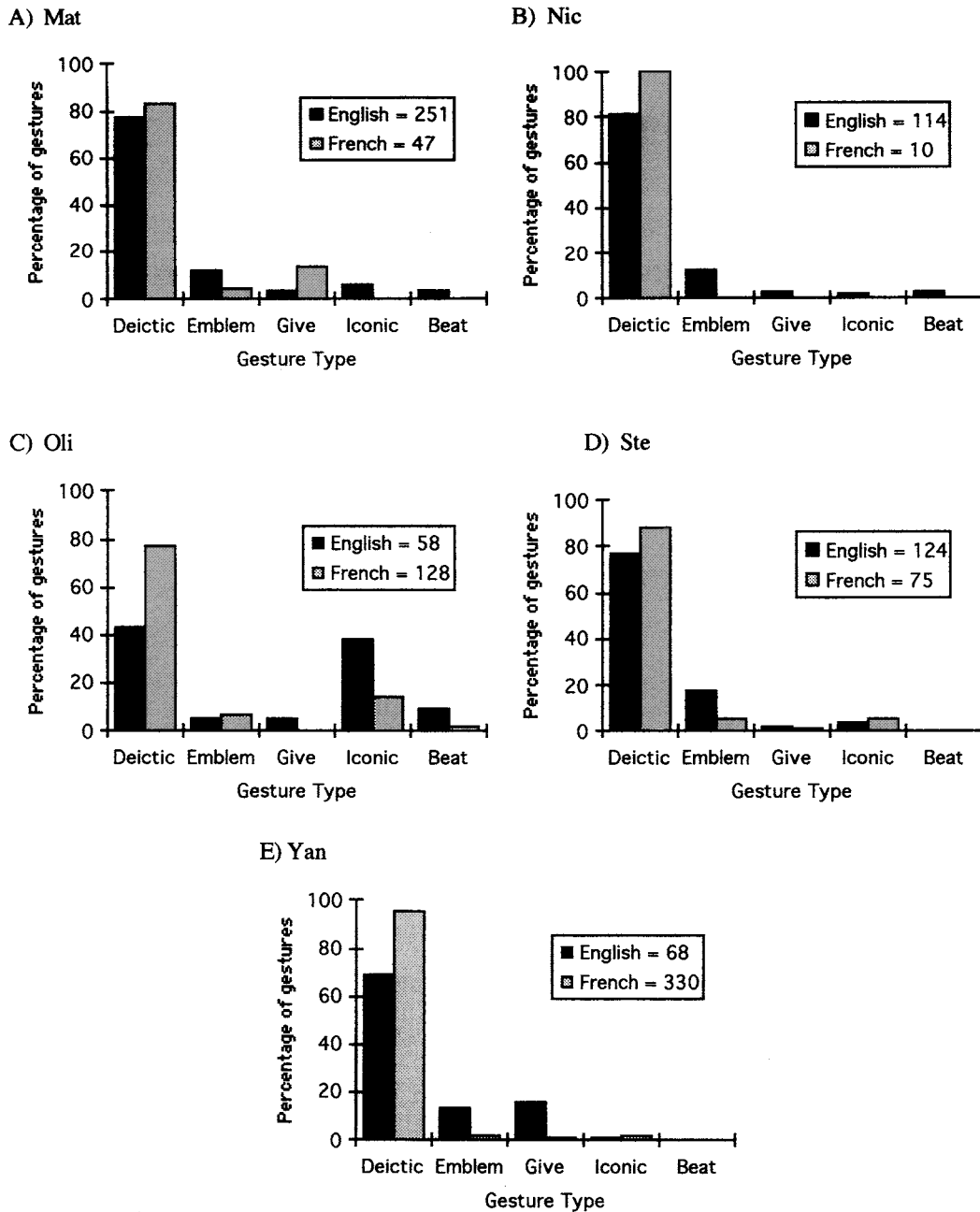


Figure 1. Percentage of gesture types with English or French by child.

tion is clearly linked to the act of speaking in young bilingual children, some gesture types might be more closely linked to language development than others. In particular, the production of iconic and beat gestures appears to be linked to language development whereas the production of point, emblem, and give gestures does not. We tested this hypothesis in detail by capitalizing on the children's unequal development in their two languages.

*Gesture and Language Development*

For the following analyses, we computed the ratio of gestures produced per utterance. This measure controlled for the variation

in the frequency of utterances across the children in English and French.

*Gesture type and English development.* To determine whether there was a relationship between English development and gesture type, we sequenced the children's English MLU from the lowest to highest level. MLU was then separated into five intervals representing approximately 0.5 increases in MLU. Care was taken to ensure that there were at least two observations at each interval. Then the mean ratio of gestures to utterance produced with the utterances at each MLU interval was computed. This computation was done separately for each of the five gesture types.

Table 3  
*Gesture Production as a Function of English Language Development and Gesture Type*

No. of observations	MLU range	Mean MLU	Gesture type				
			Iconic	Beat	Deictic	Emblem	"Give"
8	1.0–1.4	1.2	.01	.00	.19	.03	.03
6	1.5–1.9	1.7	.02	.00	.12	.03	.01
2	2.0–2.4	2.0	.02	.00	.12	.03	.01
2	2.5–2.9	2.7	.04	.01	.09	.10	.01
2	3.0–3.5	3.2	.04	.02	.27	.10	.01

Note. Gesture production is the ratio of gestures to utterances produced by each child; this measure controls for variation among children in utterance frequency. MLU = mean length of utterance.

Table 3 shows the relationship between increases in English MLU and the production of gesture–utterance as a function of gesture type. The production of points, emblems, and gives showed varying relations with increasing English MLU. The production of points–utterance was stable across the MLU range, the production of emblems increased with increasing MLU, and the production of give gestures tended to decline with increasing MLU. As for the iconics, the production per utterance tended to increase as MLU increased. Beat gestures were not produced with utterances at a length below 2.7 morphemes in English.

Correlational analyses substantiated the developmental trend between English MLU and production of particular gesture–utterance types that were apparent in Table 3. The production of iconics–utterance was positively and significantly correlated with MLU at each age sampled except 2 years 6 months: age 2 years 0 months ( $r = .95, p < .01$ ), age 3 years 0 months ( $r = .86, p < .05$ ), and age 3 years 6 months ( $r = .85, p < .05$ ; Pearson product–moment correlation,  $df = 4$ ). The production of beats–utterance was significantly and positively correlated with MLU at age 3 years 0 months ( $r = .80, p < .05$ ) and age 3 years 6 months ( $r = .98, p < .01$ ). There was no correlation between beats and utterance with MLU at ages 2 years 0 months and 2 years 6 months because beats only appeared at an MLU of 2.7 or higher (see Table 3). By contrast, the production of the other kinds of gestures (per utterance) was not correlated with MLU at any age, except for emblems–utterance at age 2 years 6 months and gives–utterance at age 3 years 6 months (see Table 4).

These results suggest that the production of iconic and beat gestures is linked to language development in English. Next we analyzed the development of French and gesture type.

Table 4  
*Correlations Between English Mean Length of Utterance and Gesture Types Produced per Utterance*

Gesture type	2 years 0 months	2 years 6 months	3 years 0 months	3 years 6 months
Iconic	.95**	.49	.86*	.85*
Beat			.80*	.98*
Deictic	-.20	-.03	-.64	-.52
Give	-.03	-.30	.16	.88*
Emblem	.24	-.80*	-.44	.32

\*  $p < .05$ . \*\*  $p < .01$ .

*Gesture type and French development.* We used the same analyses to investigate the relationship between French development and gesture type as previously used with English. First, the children's French MLU was sequenced from the lowest to highest levels and then separated into five intervals of increasing MLU. Again, care was taken to ensure that there were at least two observations at each interval. Then the mean ratio of gestures–utterance produced with the French utterances at each MLU interval was computed for each of the five gesture types. Table 5 shows the relationship between French MLU and the production of gesture–utterance as a function of gesture type. As was the case for English, the production of points, emblems, and gives did not show a uniform increase in relation to increasing French MLU. The production of points–utterance was stable across the MLU range, and the production of emblem and give gestures–utterance showed no apparent relationship to increasing MLU. At the lowest French MLU interval of 1.0, no iconics–utterance were produced. Beyond the MLU of 1.0, the production of iconics–utterance appeared stable. Beat gestures were not produced with utterances at a length below 2.0 in French.

Correlational analyses demonstrated a developmental relationship between French MLU and gesture–utterance types similar to that found for English. The production of iconics–utterance was positively and significantly correlated with MLU at two ages sampled: at 2 years 0 months ( $r = .72, p < .05$ ) and 3 years 0 months ( $r = .74, p < .05$ ; Pearson product–moment correlation,  $df = 4$ ), but not at ages 2 years 6 months and 3 years 6 months. The production of beats–utterance was positively and significantly correlated with MLU at age 3 years 0 months ( $r = .82, p < .05$ ) and age 3 years 6 months ( $r = .73, p < .05$ ) but not at ages 2 years 0 months and 2 years 6 months. Production of points–utterance, gives–utterance, and emblems–utterance was not correlated with MLU at any age, except for emblems–utterance at age 3 years 6 months, as Table 6 shows.

These results show that there is a relationship between the development of French and iconic and beat gestures. However, the evidence for this relationship is weaker than is the case for English and may be due to the fact that, as a group, the children's French was less developed than their English, as previous analyses showed.

*Utterance length and gesture type.* Another way to investigate the relationship between language development and gesture type is to compare the length of utterances produced with various types of gestures. If, as the earlier analyses showed, iconic and beat ges-

Table 5  
*Gesture Production as a Function of French Language Development and Gesture Type*

No. of observations	MLU range	Mean MLU	Gesture type				
			Iconic	Beat	Deictic	Emblem	"Give"
3	1.0	1.0	.00	.00	.08	.00	.00
7	1.1-1.4	1.2	.01	.00	.35	.01	.01
5	1.5-1.9	1.6	.01	.00	.27	.02	.03
2	2.0-2.4	2.1	.03	.01	.18	.02	.00
3	2.5-3.5	2.9	.01	.00	.19	.01	.00

Note. Gesture production is the ratio of gestures to utterances produced by each child; this measure controls for variation among children in utterance frequency. MLU = mean length of utterance.

tures are associated with increasing MLU in French and English, then utterances produced with these gesture types would be longer than those produced with points or with no gestures at all.

All utterance tokens the children produced in either English or French were grouped into four categories: utterances with no gestures, utterances with points, utterance with iconics, and utterances with beats. As Table 7 shows, utterances with no gestures were the shortest with a mean of 1.83 morphemes in English and 2.20 in French. Utterances with points were longer with a mean of 2.68 morphemes in English and 2.37 in French. Finally, utterances with iconics and beats were the longest with a mean of 3.58 morphemes in English for iconics and 3.06 for beats and a mean of 3.00 morphemes in French for iconics and 2.50 for beats. Chi-square analyses showed that the increased length in English and French utterances produced with points as compared with no gestures was significant: in English,  $\chi^2(1, N = 3,070) = 227.19$ , and in French,  $\chi^2(1, N = 2,025) = 376.23$ . In addition, the increased length of English and French utterances produced with iconics as compared with those with deictic gestures was also significant: in English,  $\chi^2(1, N = 587) = 11.77$ , and in French,  $\chi^2(1, N = 535) = 4.29$ .

*Development of Discourse-Related Gestures and Language Dominance*

Although the results presented earlier provide evidence of a developmental relationship between language and iconic and beat gestures, the question remains as to the language-specific nature of the relationship. Children's production of iconic and beat gestures might reflect increasing conceptual development that coincides with language development in an independent fashion rather than in a con-

tingent relationship with language. Because the children in the present study showed unequal development in English and French, this affords us an opportunity to directly ascertain the nature of gesture and language development. If the production of iconic and beat gestures reflects conceptual development independent of language development, then the children would show equivalent production of these gesture types across their two languages, even when the languages are unequally developed. However, if the production of iconic and beat gestures reflects development in a language-specific and language-contingent fashion, then the children would show nonequivalent production of iconic and beat gesture types in their two languages. In this section, we turn to a brief examination of this possibility.

Two children in the study, Mat and Nic, showed a more advanced English than French MLU at age 3 years 0 months and 3 years 6 months (see Table 1). Mat began to produce iconics with English utterances before his English MLU reached 2.0 (see Figure 2A). Later he began to produce beats with English utterances when his English MLU reached 3.24. During the same sampling ages, his French MLUs were 1.65 and 1.20, respectively. He produced no iconic and no beat gestures with his French utterances (see Figure 2A).

A similar developmental relationship between gesture and MLU was shown by Nic, whose English development was also in advance of his French. When Nic's English MLU reached 2.0, he produced iconic gestures with English utterances. Later when his English MLU reached 2.58, he began producing beats with English utterances, as shown in Figure 2B. During the same sampling ages, Nic's French MLU was 1.25 and 1.13, respectively. He produced no iconic and no beat gestures with his French utterances during both sampling sessions (see Figure 2B).

Table 6  
*Correlations Between French Mean Length of Utterance and Gesture Types Produced per Utterance*

Gesture type	2 years	2 years	3 years	3 years
	0 months	6 months	0 months	6 months
Iconic	.72*	.01	.74*	.49
Beat		-.05	.82*	.73*
Deictic	.08	.05	-.54	.20
Give	.40	.06		
Emblem	.68	.59	-.36	.73*

\*  $p < .05$ .

Table 7  
*Mean Length of Utterance (and Number of Utterances) in French and English by Utterance Type*

Utterances with	French	English
No gestures	2.20 (1,520)	1.83 (2,531)
Deictics	2.37 (505)	2.68 (539)
Iconics	3.00 (30)	3.58 (48)
Beats	2.50 (6)	3.06 (17)



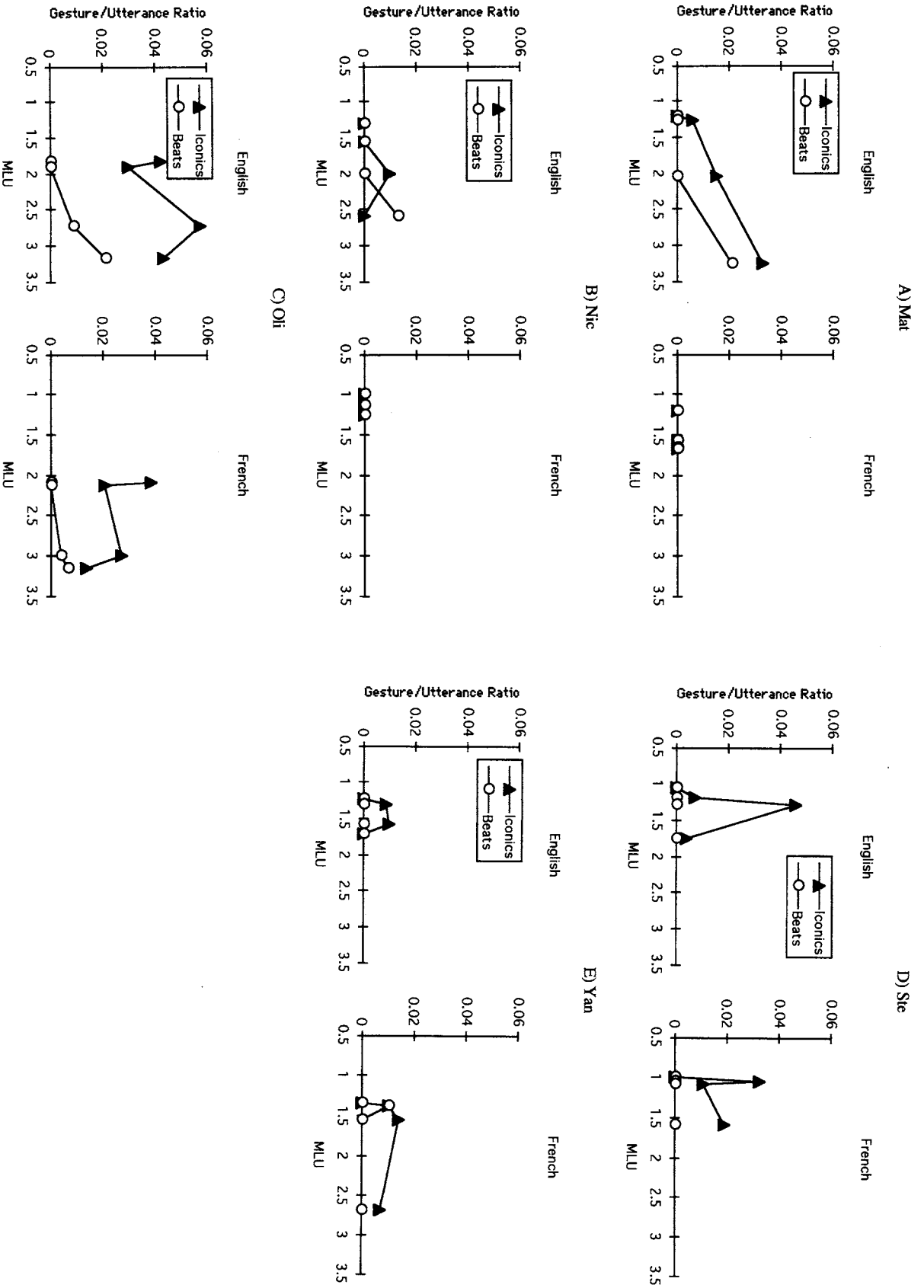


Figure 2. Gesture-per-utterance ratio for iconicity and beats as a function of mean length of utterance (MLU) in English and French by child.

Table 8  
*Types of Phrases Accompanying Iconics*

Age group	French						English					
	NP	VP	Adj	Adv	VP+	Other	NP	VP	Adj	Adv	VP+	Other
2 years 0 months	0	0	0	0	0	3	0	0	0	0	1	1
2 years 6 months	1	4	0	2	0	1	3	1	0	0	0	1
3 years 0 months	5	5	0	1	0	1	2	7	3	4	1	5
3 years 6 months	1	1	1	0	2	1	1	5	1	3	4	4
Total	7	10	1	3	2	6	6	13	4	7	6	11

*Note.* NP = noun phrase alone; VP = verb phrase alone; Adj = adjectival phrase alone; Adv = adverbial phrase alone; VP+ = verb phrase with either a noun phrase or a prepositional phrase; Other = none of the above.

Oli provided an example of balanced development in French and English over the ages studied. Oli produced iconic gestures with English utterances when his MLU was 1.90 and beat gestures with English utterances when his MLU reached 2.73 (see Figure 2C). He produced iconic gestures with French utterances with a French MLU of 2.09 and beats with French utterances when his French MLU surpassed 3.0 (see Figure 2C). Ste also showed balanced development in French and English over the ages studied. Over the course of the study, however, his development of French and English remained below an MLU of 2.0. He produced iconics with English utterances with an MLU of 1.29 and with French utterances after his MLU reached 1.04. He produced no beats with utterances in either French or English (see Figure 2D).

Finally, Yan provided an example of French development that was slightly advanced of English by the end of the study at age 3 years 6 months. Over the course of the study, his English MLU remained below 2.0, and he produced few iconics and no beat gestures with English utterances (see Figure 2E). As Figure 2E shows, Yan's French MLU reached a high of 2.68, and he began to produce iconic gestures with his French utterances when his French MLU reached a level of 1.38. His only beats with French were observed when his MLU was 1.38. In sum, although the results are not perfect, an analysis of gesture as a function of dual language development within the children show a trend of greater or more consistent use of discourse-related gestures with greater language proficiency. As such, these results support the hypothesis that iconic and beat gestures are specifically language contingent rather than language independent. In the final analysis, we investigate a possible hypothesis for this relationship.

#### *Iconic Gestures in Children's Multimorpheme Utterances*

The early, single-word utterances of young children acquiring English and French, as well as several other languages, are typically composed of more nominals than predicates (Bates et al., 1994; Cohen, 1969), with predicates becoming more frequent as language develops. Indeed, increasing use of predicate structures in early English and French development might underlie the correlation of iconic gesture production with increasing MLU. Because iconic gestures represent the actions of people or objects or the visual characteristics of people or objects (Ekman & Friesen, 1969; Kendon, 1980; McNeill, 1992), we speculated that the children may have produced them more often with verbs and verb

phrases than with nouns and noun phrases. We tested this hypothesis with the following two analyses.

We examined the phrase types spoken by the children in English or French when producing iconic gestures. We categorized each phrase into six categories: noun phrase, verb phrase, adjectival phrase, adverbial phrase, other (which included social words, interjections, and uninterpretable vocalizations), or verb phrase plus (meaning a verb phrase accompanied by a noun phrase either before or after or a prepositional phrase after). The results are summarized in Table 8. To see if iconics were accompanied more frequently by nominals or by predicates, we compared the chi-square analysis of the number of iconics with noun phrases versus the number with verb phrases, adjectival phrases, and adverbial phrases. The results of this analysis showed that the children produced iconic gestures more frequently with predicates than nominals in English and French,  $\chi^2(1, N = 51) = 14.80, p < .05$ . Note that this difference could be due to children's greater use of predicate phrases than nominal phrases; further research might take into account the proportion of children's use of each kind of phrase.

#### Discussion

The results of this study demonstrate that, between the ages of 2 years 0 months and 3 years 6 months, the child's gesture production is in many ways highly related to the act of speaking and, moreover, that some, but not all, gesture types are linked to emerging linguistic skill in a language-specific fashion. In discussing these results, we focus first on how the child's gesture production compared with that of the adult. Then we discuss those gesture types that we found to be related to spoken language development (iconics and beats) in contrast to those gesture types that were not related to language development (deictics, gives, and emblems). We also discuss the evidence for and reasons why some gesture types might be paced by linguistic factors but others are not.

By the age of 2 years 0 months, 81% of the children's gestures were produced while speaking. Thus, the children's gesture production, like that of adults, was primarily associated with the speech act even at the beginning stages of language development. Adults produce 90% of their gesture while speaking (McNeill, 1992), and 91% of the children's gestures produced at age 3 years 6 months were accompanied with spoken language. This

finding suggests that by 2 years of age, the speech-gesture system is in place in terms of coincidence.

A second similarity between adult gesture production and that of children in the age range 2 years 0 months to 3 years 6 months is that the meaning of the gestures produced matched the meaning of the accompanying speech. At age 2 years 0 months, 50% of the children's gestures matched speech meaning, and by age 3 years 6 months, 70% of gesture meaning matched the accompanying speech meaning. We found no significant difference in terms of gesture meaning by age in this study. We thus concluded that children within this age range most often convey similar meanings with their gestures and their speech.

A third similarity is that nearly all of the gesture tokens produced by the children between the ages of 2 years 0 months and 3 years 6 months were readily captured by the gesture categories used in research on adult gesture, namely, deictics, emblems, iconics, and beats. A fifth gesture type, *give*, has been found in several previous studies to be used by children younger than 20 months (Bates et al., 1979, 1983). The present results show that children continue to use this gesture from the ages of 2 years 0 months to 3 years 6 months. However, only a small proportion of the gestures, less than 5%, produced by the children were of the *give* type, and the rate decreased in these children across this age range.

Although there are many similarities between the adult and child gesture systems, this study also pointed to some important differences. Most notably, the distributional pattern of the gesture tokens produced between the ages of 2 years 0 months and 3 years 6 months was quite different from that of adults. The majority of gestures, approximately 80%, produced by the children in the present study were deictics. Similarly high rates of deictic production have been reported for monolingual children (Iverson et al., 1994; Thal & Tobias, 1992). By contrast, only a small proportion of the gestures, around 5%, produced by the children in the present study were iconics and beats. Thus, the children's gesture pattern was the reverse of the adult pattern reported by McNeill (1992), that is, approximately 4% of gesture tokens were deictics, 30% iconics, and 33% beats. This finding suggests that, although the speech-gesture system is present in structural terms (i.e., timing, meaning conveyed, and kinds of gestures used) for children who are 2 years 0 months to 3 years 6 months of age, the composition of the child's system is nevertheless somewhat different from the adult's system. We propose that the reason for this is not that children inherently gesture differently from adults but rather that their ability to express complex thought through complex language is still emerging, as we explain later. The differences between children and adults that we have observed in this study could also be attributable to the subject matter of their conversations; a study of how adults gesture when talking to children might reveal more similarities than we have observed here in terms of gesture types.

In this study, we found some evidence suggesting that for children in this age range, there are differential developmental patterns for different gestures. In particular, the gestures that have been noted in children before they begin to speak (namely, deictics, emblems, and *gives*) showed no consistent relationship to MLU in either French or English for the children in this study. We interpret this result to mean that, by and large, these gesture types are unrelated to children's language development in this age range.

In contrast, iconics and beats showed some interesting relations to the children's language development. The appearance of iconic and beat gestures with the children's utterances was associated with increasing MLU development in English and in French. Iconic and beat gestures were produced most often with multimorphemic utterances and, consequently, utterances produced with iconics contained more morphemes than utterances produced without gestures. Additional evidence for the link between the production of iconic and beat gestures and language development comes from the differential relationship they showed to the children's development in each of their two languages, especially when one language was developing much more quickly than the other. This finding suggests that iconic and beat gestures are tied to language development such that their onset is paced by the development of a particular language. This, in turn, suggests that the production of iconic and beat gestures is not paced by cognitive development in general, nor are they paced by the development of a general, linguistic capacity that cuts across languages. It is more likely that development of these gestures is tightly related to development in language.

Why should the production of iconic and beat gestures be paced by development in one particular language? One clue comes from the finding that iconic gestures were produced by the children age 2 years 0 months to 3 years 6 months in association with predicates in their accompanying spoken language as contrasted to nominals. Nominals refer to the names of categories of objects and people and are the predominate kind of word found in one-word speech. Because iconic gestures represent details of visual images associated with actions, locations, shapes, and so forth, it follows that they are more tied to the appearance of predicate structures in the child's language, namely, verbs, adverbs, adjectives, and so forth, and hence linked to increasing MLU. Iconic gestures illustrate aspects of the complex concept being expressed by the utterance predication, as, for example, in showing exactly how large the truck was or precisely how the child slid down the slide. Iconic gesture may be an inherent aspect of the expression of predication because, as McNeill (1992) proposed, its primary function is to express aspects of complex concepts that cannot be expressed in speech and hence are co-expressed cross-modally with it. Thus, the strong links between the development of iconics and the development of a particular language that we have seen in this study may be due to the children's attempts to express more complex ideas in a given language. To confirm this possibility, future studies may need to focus on the relationship between children's production of iconics and development of predicate structures in their spoken language.

As for beat gestures, we found evidence that beats increased with increasing MLU in a given language fashion; however, because the children in this study produced very few beats, our interpretation is necessarily tentative. Beat gestures illustrate the temporal structure of utterances. Indeed, unequal stress patterns across the words of an utterance are required for beat gestures to appear in adult speech (e.g., McClave, 1994, 1998). For children between 2 years 0 months and 3 years 6 months of age, this means that their language must be developed to the level of multimorphemic utterances, otherwise there are no varying stress patterns with which beat gestures can co-occur. Thus, we predict that children's beats develop as a function of their ability to use varying stress patterns with multimorphemic utterances.

In summary, this study has shown that the speech-gesture system is in many ways well established in children by the age of 2 years 0 months. Nevertheless, we have seen evidence that children's gestural system is continuing to develop through to the age of 3 years 6 months. By looking at children whose language proficiency is unequal in their two languages, we have concluded that development of iconics and beats shows a tight link to development in a given language. In contrast, prelinguistic gestures did not show these links to language development in this age range. Finally, we have speculated as to why these different gesture types might show different developmental patterns vis-à-vis language development. These speculations are necessarily limited by the data we have examined. Of particular note, these 5 children demonstrated great variability in rate of gesture production and rate of production of French and English utterances. Also, the children varied in the relative development of their proficiency of their two languages, with 3 of the children becoming increasingly proficient in English over time, whereas only 1 child became increasingly proficient in French. Future studies with more children will confirm or disconfirm our speculations.

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## Appendix

Children's Exact Age and Primary Activity for Each Filming Session  
With Father and Mother at Each Age Group

Child/parent	2;0	2;6	3;0	3;6
Mat				
Father				
Age	1;11.8	2;3.7	2;11.3	3;6.19
Activity	dinner	breakfast	toys	books
Mother				
Age	1;11.5	2;3.6	2;11.3	3;5.7
Activity	lunch	toys	toys	outside
Nic				
Father				
Age	1;11.16	2;5.22	3;1.6	3;8.15
Activity	toys	toys	toys	car
Mother				
Age	1;11.16	2;5.13	3;1.15	3;8.21
Activity	toys	sandbox	ball	puzzles
Oli				
Father				
Age	1;11.10	2;3.13	2;11.8	3;6.14
Activity	lunch	toys	toys	puzzle
Mother				
Age	1;11.15	2;3.20	2;10.29	3;6.8
Activity	toys	toys	toys	Legos
Ste				
Father				
Age	2;0.5	2;7.4	3;0.25	3;7.17
Activity	toys	skates	toys	puzzles
Mother				
Age	2;0.1	2;7.5	3;1.0	3;7.15
Activity	toys	toys	toys	toys
Yan				
Father				
Age	2;0.4	2;7.22	3;1.11	3;8.5
Activity	toys	Nintendo	books	puzzle
Mother				
Age	2;0.21	2;7.16	2;10.8	3;8.6
Activity	toys	books	books	puzzle

*Note.* Ages are expressed in years;months.days. *Activity* refers to the activity that occupied the child through most of the 20-min session. *Toys* refers to playing with a variety of toys (puzzles, cars, ball, etc.).

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