ELSEVIER

Cognition 85 (2002) 145–175

COGNITION

www.elsevier.com/locate/cognit

Thought before language: how deaf and hearing children express motion events across cultures

Mingyu Zheng*, Susan Goldin-Meadow

Department of Psychology, University of Chicago, 5848 South University Avenue, Chicago, IL 60637, USA

Received 4 April 2001; received in revised form 12 September 2001; accepted 14 May 2002

Abstract

Do children come to the language-learning situation with a predetermined set of ideas about motion events that they want to communicate? If so, is the expression of these ideas modified by exposure to a language model within a particular cultural context? We explored these questions by comparing the gestures produced by Chinese and American deaf children who had *not* been exposed to a usable conventional language model with the speech of hearing children learning Mandarin or English. We found that, even in the absence of any conventional language model, deaf children conveyed the central elements of a motion event in their communications. More surprisingly, deaf children growing up in an American culture used their gestures to express motion events in precisely the same ways as deaf children growing up in a Chinese culture. In contrast, hearing children in the two cultures expressed motion events differently, in accordance with the languages they were learning. The American children obeyed the patterns of English and rarely omitted words for figures or agents. The Chinese children had more flexibility as Mandarin permits (but does not demand) deletion. Interestingly, the Chinese hearing children's descriptions of motion events resembled the deaf children's descriptions more closely than did the American hearing children's. The thoughts that deaf children convey in their gestures thus may serve as the starting point and perhaps a default for all children as they begin the process of grammaticization – thoughts that have not yet been filtered through a language model.

Keywords: Thought; Language; Deaf and hearing children; Motion events; Cultures

1. Introduction

Children are able to learn any of the spoken languages that span the globe. Moreover, if exposed to a signed as opposed to a spoken language, children will learn that language with equal ease. The fact that children are able to deal with such a broad span of linguistic

* Corresponding author. Tel.: +1-773-702-1562; fax: +1-773-702-0886.
E-mail address: mzheng@midway.uchicago.edu (M. Zheng).

0010-0277/02/$ - see front matter
PII: S0010-0277(02)00105-1

inputs is often taken to suggest that they come to language-learning with few expectations about what kind of system they are about to learn. This hypothesis is supported, at least circumstantially, by the fact that even at the earliest stages of language-learning, children look like native speakers of the language to which they are exposed (Berman & Slobin, 1994; Choi & Bowerman, 1991).

However, the fact that children catch on to the quirks of the language they are learning very early in development does not necessarily imply that they approach language-learning without biases or predispositions. Nonetheless, it does mean that discovering those predispositions will be extremely difficult, precisely because the effect of a language model on language-learning appears to be both massive and early. In principle, the best way to determine whether children bring their own biases to language-learning is to observe children *before* they have been exposed to a language model. Unfortunately, this is not easy to do.

It is almost impossible to find a child raised by humane parents who has not been bathed in language. The few cases described of so-called "wild children" have had a social experience so deviant as to make inferences about their communications very difficult. However, there are children raised in loving homes who are unable to profit from the sea of language within which they swim – congenitally deaf children whose hearing losses are so severe that they cannot profit from the surrounding speech even with intensive oral instruction. Some deaf children of hearing parents are trained "orally" and are not exposed to a conventional sign language until adolescence. These children are effectively deprived of any usable language model during the early language-learning years, and consequently afford us the opportunity to uncover whatever biases children bring with them to the task of language-learning.

In our previous work, we have found that deaf children who are not exposed to conventional linguistic input are able to produce self-styled gestural communication systems, called homesigns. These homesign systems are similar to natural language in many respects (Goldin-Meadow, in press-a). For example, the children's gestures are structured in their syntax (Feldman, Goldin-Meadow, & Gleitman, 1978; Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1984, 1998) and morphology (Goldin-Meadow, Mylander, & Butcher, 1995) and have lexical items that work like nouns, verbs, and adjectives (Goldin-Meadow, Butcher, Mylander, & Dodge, 1994).

It is clear that the particular thoughts these deaf children convey in their gestures have *not* been influenced by a conventional language model. We therefore suggest that these thoughts come as close as we can currently envision to revealing the expressible and grammaticizable notions that children bring to the language-learning situation – thought before language.

The study of deaf children who lack exposure to conventional linguistic input can help us address a second question about language-learning. Do hearing children tend to speak like native language users merely because they are exposed to different language models, or because they are growing up in different cultures? To the extent that the language model is, on its own, responsible for cross-linguistic differences at the earliest stages of language development, deaf children developing their gesture systems across different cultures *should not* reflect these differences – precisely because they do not have access to their culture's language model. On the other hand, to the extent that the culture within which the

language model is embedded may also be responsible for the early cross-linguistic differences we see in language development, the deaf children *should* display the same differences as their hearing counterparts – since they too live in that culture.

As an example of this line of research, Phillips, Goldin-Meadow, and Miller (2001) examined the gestural narratives recounted by deaf children of hearing parents growing up in Chinese and American cultures. They found that the deaf children produced culturally specific narratives despite their lack of a verbal language model. The messages found in the deaf children's gestured narratives appear to be so central to these cultures that they are instantiated in nonverbal practices as well as verbal practices. Do nonverbal cultural practices of this sort have an impact on early communication at other levels of linguistic structure?

In this paper, we explore how children living in two different cultural and linguistic environments (Chinese and American) express motion events at an early stage in their language development. Half of the children in the study are hearing and are learning the language of their culture (Mandarin for the Chinese children, English for the American children). The other half are deaf – their hearing losses are so severe that they have not been able to acquire a spoken language, and their hearing parents have not yet exposed them to a sign language. These deaf children use gesture to communicate with the hearing individuals they encounter in their homes.

In Study 1, we ask whether the deaf children in both cultures are able to convey with their gestures the central components of a motion event despite their lack of a conventional language model. If so, we then ask whether there are differences, presumably attributable to culture, that characterize the deaf children's descriptions of motion events. In previous work, we have found no differences in sentence-level structure in the gesture systems developed by Chinese and American deaf children (Goldin-Meadow & Mylander, 1998) – despite the fact that hearing mothers in these two cultures interact differently with their children, deaf or hearing, and even gesture at different rates (Goldin-Meadow & Saltzman, 2000). If we find no differences between the Chinese and American deaf children in this study, we can consider the children's gestural productions to be their view of motion events unadulterated by language or culture – a baseline, or gold standard, against which we can then measure the effects of a language model.

In Study 2, we explore the impact that exposure to Mandarin or English has on this baseline by comparing the spoken productions of Chinese and American hearing children to the gestured productions of the Chinese and American deaf children in Study 1. Mandarin and English handle verb elements in motion events in the same way (i.e. manner is encoded in the verb, path in particles or serial verbs, Talmy, 1985). For example, in "the ball rolled down the slope" and its Chinese equivalent "球滾下斜面", manner is expressed in the verb "roll" or "滾 ", and path is expressed separately in "down" or "下". We therefore expect few differences, if any, in the verb elements produced by hearing children learning to speak Mandarin and English. In contrast, the two languages do differ in how they treat nominal elements – Mandarin allows deletion, English does not. We consequently predict differences in the nominal elements that Mandarin- and English-learners produce. In addition, we describe the words that the hearing children produce in a communication situation comparable to the deaf children's – a necessary experimental precaution to ensure that whatever differences we do find

between the deaf and hearing children are not induced by differences in the topic or context of the children's communications.

2. Study 1

The study of the expression of motion and location has played a central role in recent advances in lexical semantics. A number of scholars have contributed to the structural analysis of spatial relations and motion events (Aske, 1989; Bloom, 1996; Jackendoff, 1991; Jackendoff & Landau, 1991; Levin & Rappaport Hovav, 1991; McNeill, 1997a; Miller, 1972; Miller & Johnson-Laird, 1976; Svorou, 1994; Talmy, 1985, 1991), and a number of studies have explored the expression of motion events in early child language, finding that children use language-specific ways to express motion events from the very beginning (Berman & Slobin, 1994; Bowerman & Choi, 2001; Choi & Bowerman, 1991; McNeill, 1997b). Rich in spatial relations and language variations, motion events offer a unique arena within which the issue of linguistic relativity and universality can be examined.

Scholars have used various schemes to characterize motion events. Talmy (1985) defines a motion event as a situation in which an entity moves across space such that its initial location changes (translative motion) or moves within the space without changing location (contained motion). For Miller (Miller, 1972; Miller & Johnson-Laird, 1976), change of location or "travel" is fundamental to the verb of motion. Choi and Bowerman (1991) also focus solely on translative motions, both spontaneous and caused. Spontaneous motion is self-initiated by animate beings and is usually expressed by intransitive verbs ("the duck moved"). Caused motion is brought about by an external agent and is usually expressed by transitive verbs ("the boy moved the duck"). In our studies, we focus only on motions that involve the physical change of location, that is, on *translative* motions, both caused and spontaneous.

All languages offer their speakers the following set of semantic categories with which to describe motion events (Jackendoff & Landau, 1991; Miller, 1972; Miller & Johnson-Laird, 1976; Talmy, 1985, 1991): Motion (the presence of physical motion), Figure (the object whose path is specified), Ground (the reference point with respect to which the Figure's path is characterized), and Path (the course followed by the Figure with respect to the Ground). Other categories found in the languages include: Manner (the way the Figure moves), Cause (whether the motion is agentive or not), Direction (the deictic component of motion), Velocity (the speed of movement), and Medium and Instrument (where and how a motion is conducted).

A single lexical item can express one of these semantic categories or it can express several, thereby conflating a number of meanings within a single form. For example, either Manner or Path can be combined with Motion within a single verb (Talmy, 1985, 1991). In fact, languages across the globe can be divided into three typologically distinct groups based on which element is incorporated into the verb. One language group (satellite-framed languages) conflates Manner with Motion and expresses Path separately; English and Chinese are both examples of this typology (e.g. "he flew down" where *flew* conveys both manner and motion and *down* conveys path). The second

Table 1
Basic semantic elements in a Motion event

Elements	Meaning
Motion	the presence per se of physical motion
Path	the course followed by the Figure with respect to the Ground
Manner	the way a Figure moves or is handled along the Path
Figure[a]	the entity whose Path is specified
Origin	the point at which the Path originates
Endpoint[b]	the point at which the Path ends
Recipient[b]	the animate being at the end of the Path who receives the moving object
Place	the location in which the Path occurs
Agent	the animate being who initiates a caused motion

[a] The Figure in a motion even is frequently referred to as the Theme.
[b] The Recipient differs from the Endpoint in animacy. If the endpoint of a path is animate and receives the moving object, it is coded as a Recipient; if it is inanimate, it is coded as an Endpoint.

language group (verb-framed languages) conflates Path with Motion and expresses Manner separately; Spanish, French, and Turkish are examples (e.g. "sale volando" exits exits flying, where *sale* conveys path and motion and *volando* conveys manner). The third language group conflates Figure with Motion; many American Indian languages display this typology (e.g. in Atsugewi, the verb root "–qput-" = loose dry dirt moves, where the motion is particular to a class of figures, thus conflating figure with motion; Talmy, 1985, 1991).

Path is generally regarded as the central element of a motion event. According to Jackendoff (1991) and Pinon (1993), Paths can be divided into different types based on boundedness. The bounded Path has Source and Goal as its endpoints; the unbounded Path is characterized in terms of Direction and Route. In contrast, Lyons (1977) considers Source and Goal as separable elements that can be added to the Path. In our analyses, we too consider Path – the course or route traversed by the Figure – to be the central component of a motion event, and we follow Lyons (1977) in considering the beginnings and ends of Paths to be separable units. Thus, we include in our analyses the nine core semantic categories listed in Table 1: Motion, Path, Manner, Figure, Origin, Endpoint, Recipient, Place and Agent (caused motion only).

2.1. Method

2.1.1. Participants

Four American deaf children from the Philadelphia and Chicago areas, and four Chinese deaf children from Taipei, Taiwan, participated in the study (see Table 2). The American children were observed between the ages of 3;7 to 4;11 (years;months), and interactions between the mother and the child were videotaped every 2–3 months. The four Chinese deaf children were observed between the ages of 3;8 and 4;9, and interactions between the mother and the child were videotaped every 4–5 months.

All of the children in the study were congenitally deaf with no other reported cognitive

Table 2
Age at each observation session for the American and Chinese deaf children

	I	II	III
American deaf children			
David	3;11	4;6	4;10
Abe	3;7	3;9	4;11
Marvin	3;9	4;2	4;6
Karen	4;0	4;2	4;9
Chinese deaf children			
Ling	3;8	4;5	4;8
Bao	4;2	4;6	4;9
Fen	4;0	4;5	4;9
Qing	3;10	4;5	4;9

or physical disabilities. All had severe (70–90 dB) to profound (>90 dB) bilateral hearing losses. The hearing parents of each child had chosen to educate their child using an oral method. As a result, none of the children had been exposed to a conventional sign language such as American, Chinese, or Taiwanese Sign Language, or Signed English or Signed Mandarin. Moreover, at the time of our observations, none of the children had made any real progress in speaking English or Mandarin, producing single words occasionally and never combining those words into sentences (see Goldin-Meadow & Mylander, 1984, 1998). In general, deaf children of the same age who receive oral training rarely achieve the linguistic levels attained by hearing children or by deaf children with sign language input (Kretschmer & Kretschmer, 1978; Marschark, 1993).

Despite their lack of a conventional sign language and a usable spoken language, all eight children used gesture to communicate with their hearing parents and other hearing persons in their worlds. Moreover, the children's gestures were structured as are all natural languages, with morphological structure at the word level (Goldin-Meadow et al., 1995), predicate frames, ordering and deletion regularities, and recursion at the sentence level (Goldin-Meadow, 1982; Goldin-Meadow & Mylander, 1984, 1998), and grammatical categories (Goldin-Meadow et al., 1994). The children not only used their gesture systems to make requests and comments about the here-and-now, but they also used them to communicate about the non-present (Morford & Goldin-Meadow, 1997) and to tell stories (Phillips et al., 2001).

We concentrate in this study not on the structure of the deaf children's self-styled gesture systems, but on their content. In previous work, we examined the expression of motion events in a single American deaf child (Goldin-Meadow & Zheng, 1998; Zheng & Goldin-Meadow, 1997). In Study 1, we extend these analyses to three American and four Chinese deaf children.

2.1.2. Procedure

The data on the American deaf children come from a longitudinal study conducted during the 1970s (Feldman et al., 1978; Goldin-Meadow & Feldman, 1977) when oral

education was a frequently chosen option for educating deaf children. Data on the Chinese deaf children were collected in the 1990s in Taipei, Taiwan, where oral education remains popular. The children were videotaped in their homes during free-play sessions lasting as long as they were cooperative, typically 1–2 h. A large bag of toys was provided to facilitate communication (cf. Goldin-Meadow, 1979). The children were observed over the course of 1 or 2 years. We chose three sessions for analysis for each child, attempting to match as closely as possible the ages of the two groups (see Table 2).

2.1.3. Coding

We coded a motion event when the entity referred to was currently in the process of moving or being moved, had moved on its own or had been moved in the past, or was about to move or be moved in the future or in a hypothetical world. The discourse unit served as the basic unit of analysis. A typical discourse unit started with a request that a movement be performed on an object or a comment on an ongoing or completed movement (cf. Levinson, 1983). The partner typically replied to the request or followed up on the comment, thus elaborating on the motion event. The discourse unit usually ended when either child or mother moved on to another request–comply or question–answer sequence. Discourse units functioned to segment the continuous flow of communication.

For each motion event, we noted whether the event was initiated by some external force (caused) or was self-initiated (spontaneous), and we noted which semantic elements the child explicitly articulated in gesture over the course of the entire discourse unit. We also determined whether a gesture was a deictic (pointing) gesture or a characterizing (iconic) gesture, and described each gesture in terms of its handshape, motion, and place of articulation if it was a characterizing gesture. The following example illustrates the coding system.

This discourse unit [David 9, #24] comes from the videotapes of an American deaf child taken at age 3;11.[1] The discourse is in a question–answer format. The adult asks which toy (a guitar or a drum) goes with the soldier, and the child replies that the guitar should *not* be put on the toy soldier; the adult then puts the drum on the soldier.

> Adult: "Look at that. Look at that. Which one?" (holds up the toy guitar and drum) "Which one goes with him?"
> Child: side-to-side headshake – point at guitar – PUT ON [O-hand moved down in the direction of the soldier] – point at soldier.
> Adult: (puts drum on soldier)

The discourse unit describes a negated caused motion event (not putting the guitar on the soldier). Each of the semantic elements that could be explicitly mentioned is listed below.

[1] The first number after the child's name indicates the session during which the unit was produced, i.e. 9, and the second identifies the particular discourse unit, i.e. #24. The following conventions are used in presenting the data: capitalized words indicate characterizing gestures, − signs indicate gestures produced in sequence, + signs indicate gestures produced simultaneously; actions are in parentheses.

We note the referent for the semantic element (as best we could determine from context), and the gestures the child used to convey those referents.

	Referent	Gesture
Figure	the toy guitar	a deictic gesture (point at guitar)
Motion	the movement of the guitar piece	not expressed[2]
Path	from where the guitar was to the toy soldier	motion in a characterizing gesture (movement in PUT-ON)
Manner	the way the toy guitar is held by the hand during the movement	handshape in a characterizing gesture (O-hand in PUT-ON)
Origin	where the guitar was resting	not expressed
Endpoint	the toy soldier	a deictic gesture (point at soldier)[3]
Place	the living room	not expressed
Agent	the adult	not expressed

Reliability was established between two coders. The first coder transcribed and coded all of the tapes, which were then coded independently by a second coder. Agreement between the two coders was 98% for determining discourse unit ($N = 1028$), 89% for identifying referents of the semantic elements in each unit, and 87% for identifying gestures used to convey those referents. Overall, the Chinese deaf children produced 421 discourse units ($M = 105$, SD = 18, range = 89–128), and the American deaf children 607 ($M = 152$, SD = 51, range = 97–218).

2.2. Which semantic elements are robust?

Are the elements of a motion event so fundamental that children are able to express them without conventional linguistic input? In short, the answer is "yes". We found that both the Chinese and American deaf children produced gestures for the semantic elements considered to be essential to motion events. In fact, all four American and two of the Chinese deaf children produced all nine elements shown in Table 1; the remaining two Chinese children each omitted only one element (Agent for one child, Recipient for the other). We give examples of gestures produced to convey each element below, beginning with the verb-like elements (Motion, Manner and Path), and then turning to the nominal elements (Figure, Agent, Origin, Endpoint, Recipient, Place).

2.2.1. Verb elements

The deaf children used characterizing gestures to convey Motions, Manners, and Paths.

[2] The deaf children conveyed Motion without at the same time conveying Path or Manner by using conventional gestures borrowed from those hearing speakers produce when they talk (e.g. a flat hand held palm up, GIVE, or a pointing finger wiggling back and forth in a beckoning gesture, MOVE). These gestures are akin to bleached verbs in a hearing child's repertoire, e.g. "give", "move", "come".

[3] We classified the toy soldier as an Endpoint rather than a Recipient because the child seemed to be treating it as an inanimate location and not as an animate receiver.

We classified a gesture as expressing generic Motion when its form portrayed neither the path nor the manner of the actual motion needed to achieve relocation. For example, the GIVE gesture, open hand held palm-up as though receiving an object, was the Motion gesture most commonly used to convey caused motion. Although this gesture looks like it might be portraying the endpoint of the path (i.e. the open hand), in fact, the GIVE gesture was used whether or not the children wanted the object placed in their hands or even given to them at all. In other words, the gesture appeared to be used to mean "move" in general rather than "put it here".[4] As a second example, the MOVE gesture, pointing finger or open palm with fingers wiggling back and forth toward the gesturer, was the Motion gesture used most often to convey spontaneous motion but was also, at times, used to convey caused motion. Here again, neither the path nor the manner of motion is conveyed in the gesture, and the gesture appears to mean "move" in general. In the following example of a **Motion** element (in boldface), the child indicated that he wanted the candle moved to his friend by producing a MOVE gesture with a pointing finger wiggling back and forth in place.

- **MOVE (Motion)** – Point at friend (Recipient) – **MOVE (Motion)** [Abe 8, #36]
  Abe wanted to move a candle to his friend

We classified a gesture as expressing a Path when the hand moved across space. The gesture was considered to express Path and no other elements if the moving hand was a point or neutral handshape (cf. Goldin-Meadow et al., 1995), and if no other motion was superimposed on the trajectory (e.g. a zig-zig or hop superimposed upon a forward-moving path; see examples below). In the following example of a **Path** element, the child used a characterizing gesture to convey the proposed path that she wanted the puzzle piece to take.

- Point at puzzle piece (Figure) – **TRAJECTORY TO PUZZLE (Path)** [Bao8, #64]
  Bao wanted to put a puzzle piece into the puzzle

We classified a gesture as expressing Manner if the motion was produced in one spot (e.g. rotation of the wrist, or movement of the fingers). For example, a child used a characterizing gesture to describe the **Manner** in which snow falls – he wiggled his fingers while holding his hand in one spot. He then moved his hand straight down (fingers no longer wiggling), thus conveying the snow's path.

- **FLUTTER (Manner)** – FALL (Path) [David 9, #4]
  David was describing how snow falls

Manner could also be conflated with Path in a single gesture. The child could superimpose a second motion on the Path, e.g. a child described a frog hopping forward by moving his

[4] Five of the eight deaf children used their GIVE gestures to represent general transfer (as opposed to "put in my hand"); the three children who did not had produced relatively few GIVE gestures and thus had little opportunity to display the more generalized use. We therefore considered GIVE to be a general Motion gesture, conveying neither path nor manner explicitly, for all of the children.

hand up and down (Manner) while *at the same time* moving the hand forward (Path) [Marvin 5, #25]. The child could also add a handshape to the Path, thus conveying that the object was moved "by hand", e.g. rather than use a simple point to depict the path along which the experimenter was to move a bag, a child traced the same path using an O-shaped hand representing how the bag was to be held during the move [David 9, #8] and conflating Manner (the grasping gesture) with Path (the trajectory gesture). The American deaf children combined Path and Manner within a single characterizing gesture in 16% of their action characterizing gestures; the Chinese deaf children did so in 15% of theirs.

2.2.2. Nominal elements

The deaf children in both cultures often produced separate gestures to refer to the nominal elements of a motion event. Examples of each of the nominal elements follow in boldface.

- **Point at cookie (Figure)** – Point at napkin (Endpoint) [David 1, #26]
  David wanted the cookie put on the napkin
- MOVE (Motion) – **Point at experimenter (Agent)** [Bao 8, #46]
  Bao wanted the experimenter to move the clay rabbit to her
- **Point at key hole (Origin)** – TAKE AWAY (Path) [Qing 1, #56.5]
  Qing wanted to take the key out from the key hole
- TRANSFER (Path) – **Point at closet (Endpoint)** [David 4, #32]
  David wanted his coat put in the closet
- **Point at mother (Recipient)** – TRANSFER (Path) – **point at mother (Recipient)** [Marvin 6, #31]
  Marvin was describing how he was going to blow the bubbles toward mother
- **Point at bowling alley (Place)** – GO DOWN (Path) – PIN (Figure) [Karen 8, #70]
  Karen was describing pins going down in the bowling alley

The children either produced a pointing gesture for the nominal element, as the above examples illustrate, or an iconic characterizing gesture, as seen in the following example (cf. Goldin-Meadow et al., 1994).

- **BOARD (Place)** – MOVE FORWARD (Path) [David13, #5]
  David wanted a wind-up toy to move forward on the board

In addition to this "lexical" technique that the deaf children used to convey nominal elements in motion events, they also used a "morphological" technique. They altered the form of an action characterizing gesture to incorporate the entity to which they wanted to refer in one of two ways: (1) by producing the gesture near or toward the entity, e.g. rather than produce the GIVE gesture in neutral space at chest level, the child extended the gesture toward the cookie that he wanted moved, thereby marking the Figure morphologically; or (2) by incorporating a handshape that captured attributes of the entity into the characterizing gesture, e.g. rather than use a nondescript pointing gesture to convey the toy moving forward on the board, the child produced a fist handshape, thus capturing the bulky shape of the moving toy and, in this way, marking the Figure morphologically (cf. Goldin-

Meadow et al., 1995). At times, the children used both lexical and morphological techniques to convey the same element. For example, in both of the above examples of Place elements, the Path gesture was produced in the locale in which the act was to occur; thus, Place was redundantly marked, once lexically and once morphologically.

The children used lexical and morphological techniques equally frequently to convey the nominal elements of a motion event. The American deaf children used lexical techniques in 60% of their nominal references, and morphological techniques in 40%. The Chinese deaf children used lexical techniques in 56% of their nominal references, and morphological techniques in 44%.

2.3. How often are the semantic elements of a motion event conveyed?

Each of the eight deaf children in our cross-cultural samples produced explicit symbols (gestures) for the semantic elements that comprise a motion event. Thus, exposure to a conventional language model does not appear to be essential for children to understand the importance of each of these elements to a motion event. However, the differences that are found in children exposed to different language models typically reside, not in the basic repertoire of semantic elements, but in how often each of these elements is produced. To the extent that the expression of motion events in a young child's communication is influenced by the child's language model, the Chinese and American deaf children should show no differences in their patterns of use – after all, they have not been exposed to a language model that could influence their productions. However, to the extent that the expression of motion events can be shaped by non-language cultural factors (e.g. visual representations, physical activities, the gestures speakers produce when they talk), the Chinese and American deaf children ought to display different patterns of use in their expression of motion events.

Fig. 1 presents the mean proportion of discourse units that contained gestures for each of the nine core semantic elements, verb elements displayed in the right graph and nominal elements displayed in the left. The data for the American deaf children are in the black bars, and the data for the Chinese deaf children are in the white bars (error bars indicate standard errors). In principle, a given element could appear in any discourse unit; in other words, the proportion of discourse units within which an element appeared could be 1.00 for each of the nine elements (Agents can, of course, appear only in caused events, and the denominator for this element was adjusted accordingly).

The striking result in Fig. 1 is that children in both cultures showed almost precisely the same distribution of verb elements and nominal elements. We conducted two separate ANOVAs for verb and nominal elements, with one between-subject factor (culture) and one within-subject factor (types of elements) in each analysis (data were arcsine transformed before analysis). We found no effect of culture for either the verb elements ($F(1,6) = 0.16$, n.s.) or the nominal elements ($F(1,6) = 4.27$, n.s.). Thus, there were no differences in how often the Chinese and American deaf children produced gestures for various types of semantic elements – they considered the same elements to be worthy of mention in a conversation.

We did, however, find an effect of elements for both verbs ($F(2,12) = 12.54$, $P = 0.001$) and nominals ($F(5,30) = 82.57$, $P < 0.0001$). There were no interactions in

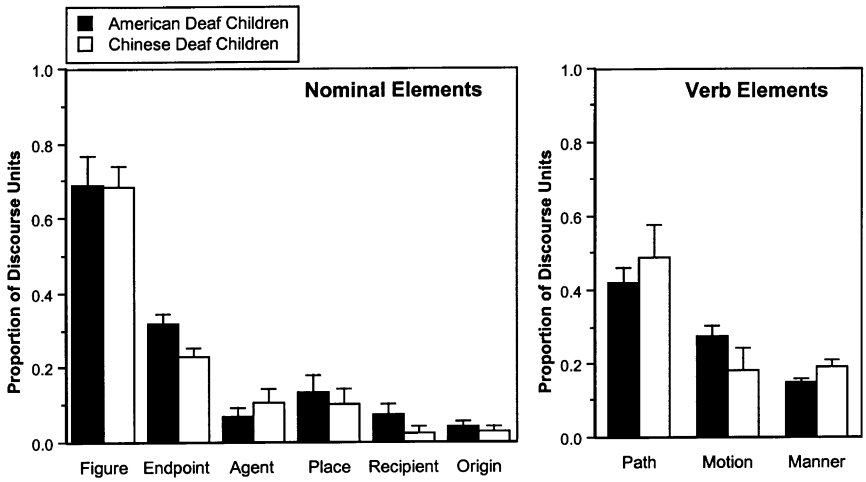

Fig. 1. The proportion of discourse units that the Chinese and American deaf children produced which contained Nominal Elements (Figure, Endpoint, Agent, Place, Recipient, Origin) and Verb Elements (Path, Motion, and Manner). A discourse element could, in principle, contain all nine elements. Thus, the proportion for each element could be as high as 1.00. Error bars indicate standard errors.

either analysis. For verbs, post-hoc comparisons (Tukey hsd) revealed that Path was produced reliably more often than either Manner or Motion in both cultures ($P < 0.01$). For nominals, post-hoc comparisons revealed that Figure was produced reliably more often than the other five elements in both cultures ($P < 0.01$), and Endpoints were produced reliably more often than the other four elements (Agents, Places, Recipients, Origins) in both cultures ($P < 0.01$). Apparently, some elements are more worthy of conversational comment than others, and cultural settings (or at least, Chinese vs. American cultural settings) do not have a major impact on these conversational preferences.

3. Study 2

The results from Study 1 suggest that, in the absence of conventional linguistic input, Chinese and American deaf children use gesture to describe motion events in precisely the same way. Whatever cultural differences exist between these two groups do not appear to have had any major impact on the way the children communicate about motion events. The deaf children's gestural descriptions can, in this sense, serve as a baseline against which to evaluate the effects of a conventional language model. To this end, we compare the spoken expression of motion events in hearing children learning Mandarin or English to the gestural expression of motion events in the Chinese and American deaf children from Study 1.

What differences might we expect in how children learning Mandarin vs. English express motion events? According to Talmy (1985), Mandarin and English do not differ in terms of how Motion, Manner and Path are conveyed in motion events. Both languages conflate Manner with Motion in the main verb, and express Path separately in a particle or serial verb. As a result, we do not expect any differences between our Mandarin-learners

and our English-learners in the expression of Motion, Manner, and Path. We might, however, expect differences between the hearing children and the deaf children. After all, having a language model – any language model – could affect how often Motions, Manners and Paths are expressed.

Unlike verbal elements, Mandarin and English *do* differ in their treatment of nominal elements in a motion event. English is a subject-prominent language in which the subject–predicate relationship plays a major role in the grammar. The grammatical or surface subject occupies a pre-verbal position and is obligatory in a non-imperative sentence, as is the object (e.g. in the sentence "Ernie is devouring the cookie", neither *Ernie* nor *cookie* can be omitted from the sentence). In contrast, Mandarin is a topic-prominent language and, as such, enjoys the freedom of deleting subjects or objects (Huang, 1984; Tsao, 1990).

Tsao (1990) has identified three major deletion processes in Mandarin:

(1) Topic NP deletion: in a topic-comment clause in Mandarin, the topic NP functions as the controller of the sentence, allowing deletion of the NP in one or more subsequent clauses. In the following example, the topic *my bird* presides over the whole two-clause topic chain sequence, allowing the subject and the object in the subsequent clauses to be deleted.

我的小鸟， 放得 下 放 不 下， 就 不 知道了。

wode xiaoniao, ∅fang-de xia fang bu xia ∅jiu bu zhidao-le

my bird (I) put (it) down put not down (I) the not know –le(particle)

Topic (Subject) (Object) (Subject)

As for my bird, (whether) (I) can put (it) inside or not, (I) don't know.

(2) Discourse theme deletion: an NP is established as the theme of the discourse and can consequently be deleted from the subsequent sentences in the discourse. The process involves a stretch of discourse, and usually the theme is pronominalized before being deleted. In the following example the mother and the child are playing with a wind-up toy. The theme is highlighted in bold:

Mom: 哦，它会 这样子 扭 屁股，它本来 应该 会 扭 屁股 的

oh, **ta** hui zheyanzi niu pigu, **ta** benglai yinggai hui niu pigu-de

oh, he can this way twist butt, he originally should can twist butt.-de(particle)

oh, he can twist his butt like this, he originally should twist butt

Child: ∅ 扭 屁股 走路。。。

(ta) niu pigu zoulu

(he) twist butt walk

(he) walks, twisting butt

(3) Speaker and hearer deletion: an NP can be deleted if it refers to either the speaker or the hearer. Similar to theme deletion, this process occurs over a stretch of discourse and the NP usually goes through pronominalization first. In this example, the mother and child start a new game, and the mother is asking the child what to do next.

Mom: 然后 呢?

ranhou -ne

next -ne (particle)

what's next?

Child: 然后 ∅ 再 按。。。

ranhou (I) zai an

next (I) again push

next, (I) will push

In addition to these three deletion processes, there is a group of sentences in Mandarin that, like the others, do not have surface subjects but, unlike the others, are grammatical even if the subject cannot be recovered from discourse (Hashimoto, 1971). As a result of this variety of deletion processes, we might expect to see Mandarin-learning children produce words for Figures (which tend to be subjects in spontaneous events and objects in caused events) and Agents (which tend to be subjects in caused events) less frequently than English-learning children.

3.1. Method

3.1.1. Participants

The motion event data from the eight deaf children of hearing parents in Study 1 served as the "gold standard" against which we evaluated the data from eight hearing children, four learning English in the Chicago area, and four learning Mandarin in Taipei, Taiwan. The hearing children were each observed during their fourth year (see Table 3). The children were matched to the deaf children to the extent possible in terms of age and gender. Mean age was 4;4 (SD = 5 months) for the American hearing children, 4;2 (SD = 5 months) for the American deaf children, 4;5 (SD = 5 months) for the Chinese hearing children, and 4;4 (SD = 5 months) for the Chinese deaf children.

3.1.2. Procedure and coding

We followed precisely the same procedure when observing the hearing children as we used in Study 1 for the deaf children. The same books and toys served as catalysts for conversation. The same coding system was used to describe the hearing children's motion event descriptions. The discourse unit again served as the basic unit of analysis. For each motion event, we noted whether the event was caused or spontaneous, and which semantic elements were explicitly articulated by the child over the course of the entire discourse

Table 3
Ages of American and Chinese hearing children

	Age
American hearing children	
Philip	4;11
Nancy	4;5
Mary	4;0
Bob	4;0
Chinese hearing children	
Yu	5;1
Hu	4;5
Peng	4;2
Zheng	4;1

unit. The following example illustrates the coding system applied to a hearing child's speech. The example comes from an American hearing child, Mary, at the age of 4;0. It is a comment sequence in which mother and child were engaged in pretend play with a toy cow and a toy dog. The child offers to give the cow a ride on her back; the mother asks the dog to give her a ride.

Child: "Get on my back cow"
Adult: "Dog, you gonna give me a ride"
Child: "Yeah"

The discourse unit describes a spontaneous motion event (a cow riding on the child's back). Each of the semantic elements that could be explicitly mentioned is listed below. Where possible, we note the referent for the semantic element as determined by the context, and the words the child used to convey those referents.

	Referent	Word
Figure	toy cow	the word *cow*
Motion	getting onto the child's back	the bleached verb *get*
Path	from the floor to the child's back	the participle *on*
Manner	cannot specify	not expressed
Origin	the floor on which the cow stands	not expressed
Endpoint	the child's back	the phrase *my back*
Place	a pretend place	not expressed
Agent	not applicable	

Reliability was established between two coders. The first coder transcribed and coded all the tapes. A subset of these tapes was then coded independently by a second coder.

Agreement between the two coders was 89% for determining discourse unit ($N = 104$), 91% for identifying referents of the semantic elements in each unit, and 91% for identifying the words used to convey those referents. We compared the hearing children's production to those of the deaf children in the two cultures at three different levels: discourse, sentence, and lexical. Table 4 displays the total number of items at each level that the four groups produced, as well as the mean number per child and the range for each group.

3.2. The impact of a language model on the expression of motion events: a discourse analysis

3.2.1. The hearing children's repertoire of semantic elements

Like the deaf children, the hearing children expressed the nine semantic elements that comprise a motion event. The hearing children expressed **Motion** (without Manner or Path) by using bleached or deictic verbs such as *bring*, *take*, *come*, and *go*.

- He (Agent) **bring (Motion)** it (Figure) back (Path) [Philip, #20]

Table 4
Number of items used in analyses at the discourse, sentence, and lexical levels[a]

	Hearing children		Deaf children	
	American	Chinese	American	Chinese
Discourse level (Figs. 1–3)				
Total number of discourse units	133	155	607	421
Mean per child	33	39	152	105
Range	21–43	38–40	97–218	89–128
Sentence level (Figs. 4 and 5)				
Spontaneous motions				
Total number of sentences	61	106	197	150
Mean per child	15	26	49	37
Range	9–23	20–36	41–62	19–49
Caused motions				
Total number of sentences	73	75	699	387
Mean per child	19	19	175	97
Range	12–28	13–28	77–243	63–120
Lexical level (Table 5)				
Total number of verbs	183	238	577	375
Mean per child	46	60	144	94
Range	29–70	42–70	101–206	76–126

[a] The deaf children in both groups were observed for three sessions, the hearing children for only one; their totals differ accordingly. The figures and tables that are based on each set of numbers are indicated in parentheses.

- 小鸡(Figure)出**(Motion)**来(Path)了 [Zheng, #38]

  xiaoji chu lai -le

  chicks **come** out -le (aspectual)

  Chicks **came** out

As befitting the typological patterns of English and Mandarin, the hearing children conflated Manner into the main verb and expressed Path separately in particles or serial verbs. We classified verbs that conflated Motion and Manner as "Manner" verbs. The term "Motion" was reserved for bleached verbs that conveyed neither Manner nor Path. In the examples that follow, **Manner** is in boldface and ***Path*** is in italics and boldface.

- They (Figure) **jumped (Manner)** ***in (Path)*** the window (Endpoint) [Philip, #16]
- 那青蛙(Figure)**就跑(Manner)*走(Path)***了

  na qingwa jiu pao zou -le

  that frog just **run** ***away*** -le (aspectual)

  That frog just **ran** ***away***

The hearing children used noun phrases to convey nominal elements in both English and Mandarin, as seen in the following examples. The first examples in English and in Mandarin involve caused motion; the remaining examples involve spontaneous motion. Noun phrases are in boldface.

- His **mother (Agent)** was walking (Manner) **him (Figure)** to (Path) the **store (Endpoint)** [Nancy, #10]
- **Davy Crocket (Figure)** get (Motion) out of (Path) **there (Origin)** [Philip, #19]
- **They (Figure)** can all go (Motion) **there (Endpoint)** [Mary, #39]
- 刚刚**我(Agent)**有去拿(Motion)卫生巾**(Figure)** [Hu, #21]

  ganggang wo you qu na weishenjin

  just then **I** went to get **napkin**

  Just then **I** went to get **napkin**
- 送(Motion)到(Path)台北医院吗**(Endpoint)**，哦，台北医院**(Endpoint)** [Peng, #52]

  song dao Taipei yiyuan ma, oh, Taipei yiyuan

  take to **Taipei Hospital,** oh, **Taipei Hospital**

  (shall we) take (the injured) to **Taipei hospital**

- 要过(Motion) 山洞 **(Place)** [Hu, #42}

  yao guo shandong

  will pass **tunnel**

  (toy train) will pass (through) the **tunnel**

In both English and Mandarin, Agents typically serve as subjects in transitive sentences conveying caused motion, Figures serve as objects of the main verb, and Origins, Endpoints, Recipients, and Places serve as objects of prepositions or particles. Figures typically serve as subjects in intransitive sentences conveying spontaneous motion, and Origins, Endpoints, Recipients and Places serve as the objects of prepositions or particles.

The question we now turn to is whether the particular language to which the children were exposed (Mandarin vs. English) affected how often the children mentioned semantic elements in a motion event. We look first at the hearing children's production of verb elements and then turn to nominal elements. In each case, we compare the hearing children's productions to those of the deaf children from Study 1.

3.2.2. Verbal elements

Fig. 2 presents the mean proportion of discourse units in which the hearing and deaf children produced words or gestures for Paths, Motions, and Manners. The deaf children's data are displayed in the right-hand bars in each graph, and the hearing children's data are displayed in the left-hand bars. The data for the American children are in the black bars, and the data for the Chinese children are in the white bars (error bars indicate standard errors).

The patterns in Fig. 2 suggest that language model has no effect on the production of **Paths** – all four groups of children produced words or gestures for Paths in approximately 50% of their discourse units. An ANOVA with two between-subjects factors, culture (American, Chinese) and hearing status (deaf, hearing), found no effect of culture ($F(1, 12) = 0.00$, n.s.) or hearing status ($F(1, 12) = 0.10$, n.s.) and no interaction ($F(1, 12) = 1.19$, n.s.). In contrast, being exposed to a language model, Mandarin or English, did have an effect on the production of both **Motions** and **Manners** – the hearing children produced more Motions

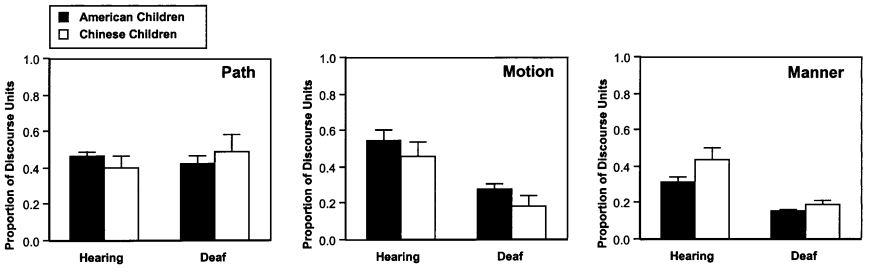

Fig. 2. Verb elements. The proportion of discourse units that Chinese and American hearing children and Chinese and American deaf children produced which contained words or gestures for Path, Motion, or Manner semantic elements. Error bars indicate standard errors.

($F(1, 12) = 20.90$, $P = 0.0006$) and more Manners ($F(1, 12) = 24.94$, $P < 0.001$) than the deaf children. There was no effect of culture on either Motions ($F(1, 12) = 2.56$, n.s.) or Manners ($F(1, 12) = 4.18$, $P = 0.06$, marginal), and no interactions.

To determine whether the language model affected the *types* of verb elements that the children expressed, we listed all of the different lexical types that the deaf and hearing children produced for Motions, Manners, and Paths (see Table 5). The number of times each word or gesture was produced by the children in a group is presented in parentheses next to each lexical item. We were, of course, forced to construct glosses for the deaf children's gestures. Finding an appropriate gloss for a gesture is difficult simply because a slight change in handshape or motion could indicate a new gesture. Thus, the glosses in the table may not reflect all of the variations in meaning that the deaf children intended. However, we did make every effort to isolate the prototype form for gestures with similar meanings, and to match that prototype to its nearest English equivalent (see Goldin-Meadow et al., 1994, for a description of this procedure).

As can be seen in Table 5, the range of meanings for Motions, Manners, and Paths did not differ across the different groups of children. The children focused on the movement of the Figure in their Motion verbs. In the hearing children, these meanings were expressed by lexical items such as *come*, *go*, *put*, *get*, *take*, *bring*, *move up* and *down*. In the deaf children, the meanings were expressed by gestures such as GIVE, MOVE, COME and LEAVE.[5] The meanings for Manner verbs were more specific and varied across all of the groups. The hearing children used words such as *stick*, *fall*, *pick*, *pull*, *carry*, *pop*, *walk*, *run*, *jump*, *swim*, *hop*, *climb*. The deaf children used gestures glossed as FLY, POP-UP, PULL, PEEL, GRASP, TWIST, DRIVE, SWIM, HOP, CLIMB and CRAWL. Finally, the hearing children used words such as *in*, *out*, *up*, *down*, *to*, *back*, *forward*, *through* to convey Path, which were roughly comparable to the deaf children's gestures for Path.

Note that neither the Chinese nor American hearing children conflated Manner and Path. It is possible to produce such a conflation in both languages (English "flee" is an example, as in "I fled to the town"; Talmy, L., personal communication); however, such examples are rare in English and Mandarin. The Chinese and American deaf children in our sample did produce Manner + Path gestures, as Table 5 illustrates. Although the children produced a variety of different types of Manner + Path gestures, these conflated gestures accounted for a relatively small proportion of the deaf children's verb gestures (0.15).

3.2.3. Nominal elements

Like the deaf children, the hearing children rarely mentioned Origins, Recipients, and Places. Indeed, only one American hearing child mentioned either Origin, Recipient, or Place; one Chinese hearing child mentioned Origin, and two mentioned Place. Overall, the American and Chinese hearing children mentioned each of these elements in fewer than

[5] GIVE, MOVE and COME are three conventional gestures conveying Motion. They differ in terms of the movement of the hand and fingers, and the orientation of the palm. For GIVE, the palm is usually held flat in front of the chest facing upward. There is no finger or hand movement. MOVE is similar to GIVE, except that the fingers wiggle. Sometimes only one or two fingers wiggle, other times all fingers move together, but they bend at the knuckles rather than the palm. COME is coded when the fingers (either the index finger or all four fingers in unison) bend at the palm, wrist, or elbow, essentially flapping toward the body.

Table 5
Lexical items used for Motion, Manner and Path in deaf and hearing children

	Home signs (total=952)	English (total=183)	Chinese (total=238)
Motion verbs	GIVE (266) – a flat palm up hold in front of chest MOVE, COME (54) – pointing finger or open palm with fingers wiggling back and forth LEAVE (1) – a flat palm up waving toward outside	put (20) take (5) bring (2) get (21) go (21) go get (1) come (7) move (1) stand (something up) (1) do (=run) (1)	放 (7)，弄 (1)，装 (2)，摆 (4)，关 (15) – put 拿 (3)，送 (1)，带 (1)，要 (1) – take 进 (6) – enter 出 (17) – exit 上 (1) – ascend 下 (5)，下车 (1) – descend 回 (3) – come back 到 (1) – reach 过 (3)，动 (9)，开 (4)，走 (4) – move 用 (2) – push but without Manner 去拿 (1) – go get
Manner verbs	HOP (8) FLY (3) POP (UP) (2) PUT-A-FLAT-THING (IN) (1) PULL (1) DRIVE (2) SWIM (6) PEEL (4) CLIMB (1) CRAWL (3) GRASP (1) TWIST (1)	carry (2) pull (1) pick (2) fall (3) walk (11) sleep-walk (1) run (1) jump (2) climb (1) swim (2) hop (2) pop (2) ride (2) gallop (1) stick (out) (1) swing (1) zip/unzip (2)	载 (1) – carry 捡 (1) – pick 掉 (9)，倒 (6)，摔 (7), 跌 (8) – fall in different manner 走 (2)，走路 (1)，散步 (1) – walk 跑 (6) – run 跳 (3) – jump 爬 (1) – climb 滚 (1) – roll 挤 (1) – push through 戴 (1) – put on clothings 按 (2) – press with force 飞 (14) – fly 伸 (1) – stick out 丢 (2) – throw 盖 (2) – cover 吃 (2) – (food) go down
Path verbs or particles	(move, move something) ALONG-A-PATH (177) (put, go, dive) IN (47) (put) ON (12) (move, move something) UP (53) (move, move something) DOWN (127) (take, pull) OUT (13) (take, remove, pull, peel, fall) OFF (7) (go, move, push) FORWARD (9) (go) THROUGH (3) (put, throw) AWAY (2) (go) TOWARD (1) (move) INTO (1)	in (15) inside (1) to (7) on (4) out (12) out of (2) up (6) down (3) back (8) back in (2) back to (1) through (1) away (2) around (1) round (1)	在 (2) – in, on 进去 (4) – in, inside 去 (14) – to, toward 出去 (6) – out, outside 到 (19)，来 (16) – reaching, toward, onto 起来 (1) – up 下 (1)，下来 (4)，下去 (4)，倒 (1) – down 从 (1) – from 走 (1) – off
Path+ Manner	GRASP+MOVE (16) POP+UP (8) MOVE+ RELEASE (3) CLIMB+UP (3) HOP+FORWARD (2) FLUTTER+ DOWN (2) PEEL+OFF (1) PICK UP+MOVE (1) POUNCE+GRAB (1) TURN+ MOVE DOWN (1) CARRY+BY HAND (108)	None	None

2% of their discourse units. They did, however, mention Figures and Endpoints and, unlike the deaf children, they frequently mentioned Agents. Fig. 3 presents the mean proportion of discourse units in which the hearing and deaf children produced words or gestures for Figures, Endpoints, and Agents.

We conducted an ANOVA with two between-subjects factors, culture (American, Chinese) and hearing status (deaf, hearing), on each element. As can be seen in Fig. 3, the children did not differ in their production of **Endpoints**. Neither culture ($F(1, 12) = 4.06$, n.s.) nor hearing status ($F(1, 12) = 3.15$, n.s.) had an impact on whether the children produced words or gestures for Endpoints – children in all four groups produced Endpoints in approximately 20% of their discourse units.

In contrast, the children did differ in their production of **Figures**. Culture had an effect on the production of Figures ($F(1, 12) = 8.48$, $P = 0.01$) whereas hearing status did not ($F(1, 12) = 0.18$, n.s.). There was, however, an interaction ($F(1, 12) = 7.8$, $P = 0.02$) of factors, and post-hoc comparisons (Tukey hsd) revealed that the effect was carried by the hearing children – the American hearing children produced significantly more Figures than the Chinese hearing children ($P < 0.01$).

The children also differed in their production of **Agents**. Culture had an effect on Agents ($F(1, 12) = 11.54$, $P = 0.005$), as did hearing status ($F(1, 12) = 52.18$, $P < 0.0001$). Again, there was an interaction of factors ($F(1, 12) = 16.53$, $P = 0.002$), and post-hoc comparisons (Tukey hsd) revealed that the American hearing children produced significantly more Agents than each of the other three groups ($P < 0.01$).

3.2.4. Summary of effects at the discourse level

Recall that the Mandarin and English languages do not differ in terms of how Motion, Manner and Path are conveyed in motion events (Talmy, 1985). We therefore did not expect differences in how Mandarin-learning and English-learning children talk about Motions, Manners, and Paths – and, indeed, we found none. We did find, however, that the hearing children who were exposed to a conventional language model produced more Motions and Manners than the deaf children who were not. Thus, one effect that a language model can have on a child's expression of motion events is to boost production of particular elements.

In contrast to their treatment of verb elements, Mandarin and English do differ in their treatment of nominal elements in a motion event. And here we did find differences

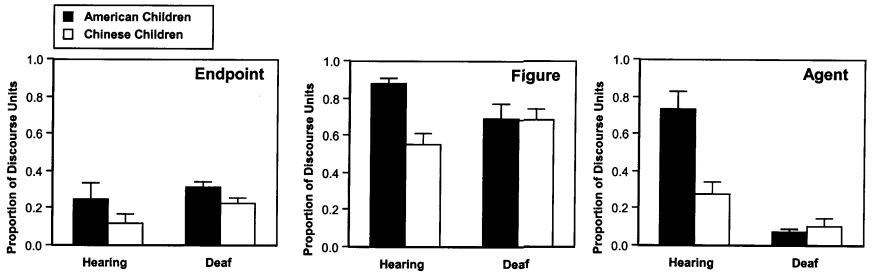

Fig. 3. Nominal elements. The proportion of discourse units that Chinese and American hearing children and Chinese and American deaf children produced which contained words or gestures for Endpoint, Figure or Agent semantic elements. Error bars indicate standard errors.

between our Mandarin-learning and English-learning groups in their production of Figures and Agents – the elements that serve subject and object roles. Not surprisingly given that subject and object deletion is not typically an option in English sentences, the American hearing children produced more Figures and Agents than their Chinese counterparts. We return to this issue in the next section where we discuss how the children packaged the semantic elements of a motion event into sentences.

3.3. Packaging the semantic elements of a motion event into sentences

We have looked at the children's abilities to express the semantic elements of a motion event across a number of turns in a discourse unit. The question we next address is – how are those elements packaged into sentences? The fact that Mandarin, but not English, permits subject and object deletion should lead to differences in how the Chinese and American hearing children construct sentences conveying motion events. We first examine how often the children in each group produced nominals on their own (e.g. "dog"), verbs on their own ("runs"), or verb + nominal combinations ("dog runs" or "dog runs there").

3.3.1. Single elements vs. sentences

Fig. 4 presents the mean proportion of sentences in which children from all four groups produced single nominals (left graph), single verbs (middle graph), and combinations of a verb plus one or more nominals (right graph). The first point to note is that, as we have now come to expect, the Chinese and American deaf children displayed precisely the same pattern: they produced verb + nominal combinations in approximately half of their sentences, a sizeable number of single nominals, and relatively few single verbs.

What effect does a language model have on this basic pattern? Being exposed to a language model, either English or Mandarin, encouraged the children to produce fewer single nominal elements. We found an effect of hearing status ($F(1, 12) = 17.02$, $P = 0.001$) but no effect of culture ($F(1, 12) = 0.05$, n.s.) and no interaction ($F(1, 12) = 0.12$, n.s.) on the production of single nominals. The hearing children in both cultures produced fewer single nominals than the deaf children.

Moreover, the *particular* language to which the child was exposed mattered for the production of single verbs and verb + nominal combinations. Deletion of nominal elements is permitted in Mandarin but not English, and our hearing children seemed to have already learned this fact about their languages. The Mandarin-learning children produced a relatively large proportion of single verbs, whereas the English-learning children did not. In contrast, the English-learning children produced a large proportion of verb + nominal combinations, whereas the Chinese-learning children did not. We found effects of culture ($F(1, 12) = 12.62$, $P = 0.004$), hearing status ($F(1, 12) = 4.99$, $P = 0.04$), and an interaction of factors ($F(1, 12) = 12.85$, $P = 0.003$) on the production of verb elements, and on the production of verb + nominal combinations (culture, $F(1, 12) = 12.62$, $P = 0.004$; hearing status, $F(1, 12) = 4.99$, $P = 0.04$; interaction, $F(1, 12) = 12.85$, $P = 0.004$). Post-hoc comparisons revealed that, in each case, one group was responsible for the effect: the Chinese children produced more single verbs than the other three groups ($P < 0.01$), and the American children produced more verb + nominal combinations than the other three

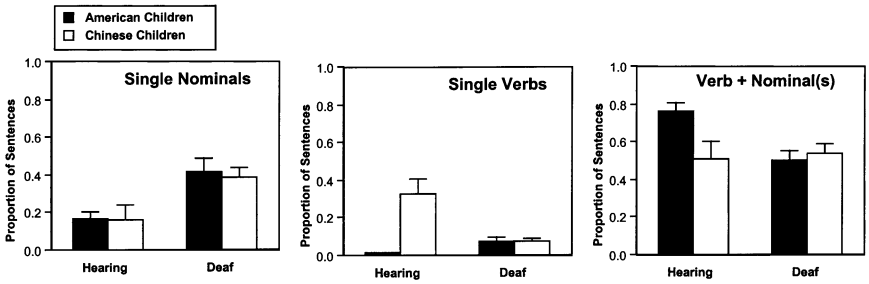

Fig. 4. Packaging semantic elements in sentences. The proportion of sentences that the Chinese and American hearing children and the Chinese and American deaf children produced containing single nominal elements, single verb elements, and verb plus one or more nominals in combination. Error bars indicate standard errors.

groups ($P < 0.01$). We look next at how these biases affect the production of particular semantic elements in descriptions of spontaneous vs. caused motions.

3.3.2. Production and deletion of nominal elements

Figures and Agents are obligatory in English, but not in Mandarin. Mandarin permits the deletion of both subjects and objects in certain contexts and, in fact, young Mandarin-learning children have been found to delete both, although (like adult Mandarin-speakers) they are more likely to delete subjects than objects (Wang, Lillo-Martin, Best, & Levitt, 1992). Note, however, that the category subject includes two different types of elements in a motion event – Agents in caused motions, and Figures in spontaneous motions. The question we ask is whether the Chinese hearing children treat Agent subjects in the same way that they treat Figure subjects. The answer is that they do not – the Chinese hearing children (and the Chinese and American deaf children as well) delete Agents, not Figures. In other words, they do not delete all subjects in motion events, only subjects playing an agent role.

Fig. 5 presents the mean proportion of sentences with verbs in which children from all four groups produced Agents in caused motions (subjects, "the *boy* moved the duck"), Figures in spontaneous motions (subjects, "the *duck* moved"), and Figures in caused motions (objects, "the boy moved the *duck*"). As we have now come to expect, there were no differences between the Chinese and American deaf children, this time at the sentence level: both groups produced Figures in spontaneous motions significantly more often than they produced Agents in caused motions ($t(3) = 4.875$, $P = 0.02$, Chinese deaf children; $t(3) = 5.26$, $P = 0.01$, American deaf children), and as often as they produced Figures in caused motions ($t(3) = 0.83$, n.s., Chinese deaf children; $t(3) = 1.17$, n.s., American deaf children).

Being exposed to English had the predictable effects, boosting production of Agents in caused motions, Figures in spontaneous motions, and Figures in caused motions to almost 100%. The interesting pattern is found in the Chinese hearing children. As expected, they deleted elements more often than the American hearing children, but they did not delete both types of subjects equally. Like the deaf children, they produced Figures in spontaneous motions (subjects) more often than Agents in caused motions (subjects)

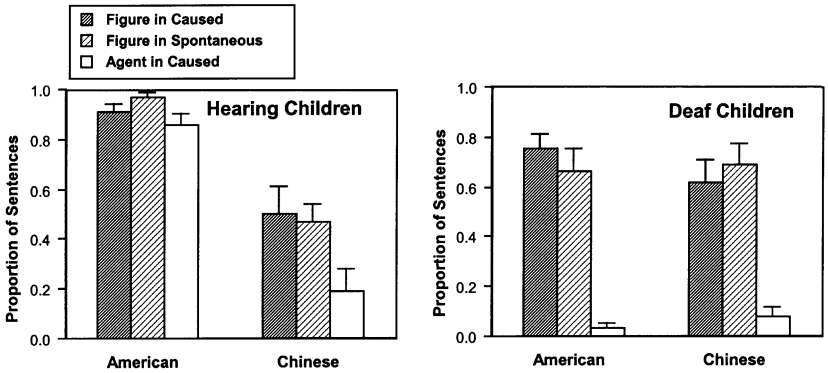

Fig. 5. The proportion of sentences produced by the Chinese and American hearing children and the Chinese and American deaf children that contained Figures in Caused sentences, Figures in Spontaneous sentences, and Agents in Caused sentences. Error bars indicate standard errors.

($t(3) = 3.05$, $P = 0.055$), and as often as they produced Figures in caused motions (objects) ($t(3) = 0.27$, n.s.).

4. Discussion

4.1. The central elements of a motion event can be developed without a language model

We have shown that deaf children who are not exposed to a usable model of a conventional language are nevertheless able to create gestures to communicate about motion events. Even more striking, these children create gestures for all nine of the semantic elements considered to be central to grammaticizing a motion event without guidance from a language model.

In addition, we have found that deaf children raised in two very different cultures package the elements of a motion event in precisely the same ways. At the discourse level, children from both Chinese and American cultures are more likely to produce gestures for paths than manners or motions, and more likely to produce gestures for figures and endpoints than agents, places, origins, and recipients. Given that the deaf children are capable of producing gestures for all of the semantic elements central to a motion event, expressing certain elements more frequently than others does indeed reflect a real choice. As an example, when the deaf children fail to produce gestures for agents, it is not because they can not. They routinely produce gestures for agents in sentences that have two-argument predicate frames (i.e. sentences involving an agent and patient), even though they rarely produce them in the sentences with three-argument predicate frames that we have examined here (i.e. sentences involving an agent, patient, and endpoint or recipient; Goldin-Meadow, 1985). It is not surprising that the deaf children omit semantic elements from the surface structure of their sentences – like all children at the early stages of language development, their sentences tend to be short and therefore cannot accommodate all of the elements in a motion

event. The question, however, is what determines which particular elements are gestured and which are omitted in the deaf children's communications?

There are a number of possibilities. The most obvious is that the deaf children produce gestures for just those elements that are uppermost in their thoughts at the moment – that is, the elements that are salient to them. But the influence could also come from the communication situation itself – that is, the elements that the children consider worth telling to a communication partner. Another possibility is that the frequency with which the deaf children express a particular semantic element reflects the ease with which that element can be encoded in the manual modality. Perhaps figures and paths are particularly easy to convey in gesture. However, although it is easy to point at figures, it seems equally easy to point at agents, origins, or endpoints. Moreover, even though it is easy to convey a path in gesture (all the child need do is move a hand across space), conveying manner seems no harder[6] – to indicate that a bag was moved "by hand", the child merely has to add a grasp handshape to the path; to indicate that a (toy) frog crossed the room "by hopping", the child has only to add an up-and-down motion to the path. In fact, and we think importantly, including manner in the path actually results in a gestural representation that is *closer* to the real world event than the stripped down path – in the actual event, the hand does form a grasp as it carries the bag across space, and the frog does move up and down as it crosses the room. Thus, although the manual modality undoubtedly plays some role in determining what the deaf children can and cannot express in their gestures, its a priori impact on the expression of motion events is unclear.

There is another possible explanation for the pattern of motion event elements the deaf children convey. Although the deaf children are not exposed to a conventional language model, they do see the spontaneous gestures that their hearing parents produce as they talk. Perhaps those gestures serve as a model for the patterns the American and Chinese deaf children display in their gestured descriptions of motion events. In previous work, we have found that the hearing parents' gestures are not structured like their deaf children's gestures and thus cannot serve as a model for those gestures (Goldin-Meadow & Mylander, 1983, 1984, 1998).[7] However, the hypothesis will have to be explicitly explored with respect to motion events. We do know that the deaf children are likely to have copied their motion gestures (GIVE, MOVE, COME) from the emblems that their hearing parents and other hearing individuals in their culture produce. However, the deaf children used these gestures differently from their parents. GIVE was the children's predominant motion gesture (0.84 American children; 0.79 Chinese children); MOVE and COME were the mothers' predominant motion gesture (0.71 American mothers; 0.67 Chinese mothers; their remaining motion

[6] Manner seems to be easily represented in conventional languages that are based in the manual modality, both in established sign languages (e.g. American Sign Language, ASL; Supalla, 1982, 1990) and in young sign languages that are still developing (e.g. Nicaraguan Sign Language, NSL, which has evolved over the last two decades out of home-made gesture systems into a recognized language; Senghas, Ozyürek, & Kita, 2001). In fact, preliminary analysis of NSL signers suggests more manner than path in both adolescents and adults (Senghas, A. personal communication).

[7] The deaf children's hearing parents very rarely gestured to their children without talking – they were, after all, attempting to teach their children to talk. As a result, the gestures they used with their deaf children look no different from the gestures that all speakers produce when they talk (Goldin-Meadow, McNeill, & Singleton, 1996).

gestures were GIVE). Moreover, the children used GIVE to communicate about transfer of objects to themselves and to other places; the mothers used it to communicate about transfer only to themselves. In addition, the deaf children used their motion gestures about as often as the hearing children in the two cultures used their bleached verbs (0.40 of verbs for the American deaf children; 0.43 for the American hearing children; 0.24 for the Chinese deaf children; 0.38 for the Chinese hearing children); that is, all children – with or without a language model – communicate equally often about movement across space without specifying the path or manner of that movement.

At this point, we cannot yet identify the causes that underlie the deaf children's preferential treatment of certain semantic elements. But we do know that a conventional language model cannot be among those causes – the deaf children did not have access to such a model. Nor, our data suggest, is their expression of semantic elements in motion events affected by whatever cultural differences exist between our Chinese and American samples (and there were many differences between the groups, cf. Goldin-Meadow & Saltzman, 2000). Interestingly, the differences in nonverbal practices between these two cultures did seem to have an impact on the early narratives the Chinese and American deaf children produced (Phillips et al., 2001). However, these same differences had no influence on how the children communicated about motion events.

Of course, other cultures may differ from the Chinese and American cultures we have examined in ways that have the potential to influence the deaf children's expression of motion events. As an example, the gestures that Spanish-speakers produce when they talk are distinctly different from the gestures that English- and Mandarin-speakers produce (McNeill & Duncan, 2000). Spanish-speakers produce gestures for manner more often than English-speakers (McNeill, 2000), and those gestures tend to spread through multiple clauses (McNeill, 1998). As a result, manner gestures may be longer and more salient to a deaf child growing up in a Spanish culture than to a deaf child growing up in an American culture.

If, despite this difference, deaf children in Spanish cultures turn out to package motion events in the same way as the deaf children that we have studied in American and Chinese cultures, we will have further evidence of the strong biases that children themselves bring to the expression of motion events. If, however, Spanish deaf children differ from Chinese and American deaf children in the way they package motion events, we can begin to explore how children's construction of motion events is influenced by the differing cultural models they experience.

4.2. Language models influence how motion events are packaged

We explored in our study the impact of two particular language models, Mandarin and English, on hearing children's expression of motion events at the early stages of language-learning. We found that, not surprisingly, the language model to which children are exposed does indeed affect the way those children describe motion events. Importantly, the differences that we found between our Mandarin-learning and English-learning hearing children appear to stem from the *language models* to which they are exposed, and not from other cultural differences that the two groups of children undoubtedly experience – after all, the

deaf children in our study experienced the same non-linguistic cultural worlds as the hearing children, yet they displayed *no* differences in the way they expressed motion events.

As predicted from the structure of English and Mandarin, we found no differences in how often the English-learning and Mandarin-learning hearing children produced words for paths, manners, and motions. More striking is the fact that even languages that vary along this dimension (e.g. Spanish) appear to have little effect on how often children produce paths and manners very early in development. Naigles, Eisenberg, and Kako (1992) found that when American and Spanish children first begin to talk at age 2, they both produce more path expressions than manner expressions despite the fact that Spanish and English differ in how paths and manners are expressed. The preference for manner verbs found in adult English-speakers only begins to manifest itself by the end of the third year and slowly increases over time (Hohenstein, Naigles, & Eisenberg, in press). It seems to take time for a language model to impact on the child's expression of path and manner.

English and Mandarin did, however, have predictably different effects on the hearing children's production of nominal elements. Mandarin has a number of devices that allows subjects and objects to be deleted from a sentence. English has very few such devices and those devices are not often used. The Chinese and American hearing children in our study seemed to have already grasped this fact about their languages. The English-learning children never omitted subjects from their sentences (either agents in caused motions or figures in spontaneous motions), nor did they omit objects (figures in caused motions; see Fig. 5). The American children consequently expressed these elements significantly more often than their Chinese counterparts.

The Chinese hearing children's sentences were, in a sense, less constrained than the American hearing children's. Deletion is permissible in Mandarin, but it is not obligatory. It is therefore interesting that the pattern seen in the Chinese hearing children's sentences more closely resembled the deaf children's pattern (both Chinese and American) than did the American hearing children's pattern. In other words, when the children had the option of deleting their subjects and objects, they tended to follow the deaf children's pattern – frequent production of figures in spontaneous motions (subjects) and in caused motions (objects), and relatively infrequent production of agents in caused motions (subjects).

We thus have found, as Wang et al. (1992) have before us, that Chinese hearing children display an asymmetry in their deletion patterns. It is important to note, however, that this asymmetry was not found between *all* subjects and objects, as Wang et al. (1992) might be taken to suggest. The Chinese children in our study showed a bias to delete *only* the subjects of caused motions (agents), not the subjects of spontaneous motions (figures). Subjects of spontaneous motions were produced as often as objects. Thus, *subject* is too broad a term to describe the Chinese hearing children's deletion patterns. Our next step ought to be to examine the spontaneous productions of *adult* Mandarin-speakers to determine whether their deletion bias is truly a bias to delete all subjects, or a bias to delete only the subjects of transitive sentences.

Interestingly, when hearing children are exposed to Korean (Clancy, 1993), Inuktitut (Allen & Schroder, in press), and Samoan (Ochs, 1982), all languages that permit deletion, they too follow the deaf children's pattern – they delete transitive subjects and produce intransitive subjects and objects. Indeed, at earlier stages of development when English-

learning children have been found to delete nominal elements despite their obligatory status (Bloom, Miller, & Hood, 1975; Hyams, 1986; Valian, 1991), these children also delete transitive subjects but not intransitive subjects or objects (Goldin-Meadow & Mylander, 1984, p. 63).

The deletion pattern found in all of these hearing children and the deaf children is reminiscent of structural arrangements found in ergative languages, where subjects of intransitive sentences (figures in spontaneous motions) are treated grammatically just like objects of transitive sentences (figures in caused motions), and different from the grammatical treatment of subjects in transitive sentences (agents in caused motions; Dixon, 1979; Silverstein, 1976). DuBois (1987) has suggested that the ergative pattern is found at the discourse level in *all* languages. Moreover, in recent work, we have found that when asked to describe a series of action vignettes using their hands rather than words, English-speaking adults invent an ergative structure identical to the one developed by the deaf children in our studies, rather than the accusative pattern found in their spoken language (Goldin-Meadow, Yalabik, & Gershkoff-Stowe, 2000). Taken together, these observations suggest that the ergative pattern is robust in communication situations involving both adults and children. When not forced by a language model to adopt a non-ergative structure, language-learners and language-creators alike fall back on ergative structure (see Goldin-Meadow, in press-b, for discussion).

In sum, we have found that, in the absence of a conventional language model, deaf children invent gesture systems that convey the central elements of a motion event. Moreover, deaf children growing up in an American culture use their gestures to express motion events in the same ways that deaf children growing up in a Chinese culture do. The ideas that the deaf children convey in their gestures when they express motion events are likely to reflect what the children know about their surrounding physical world. In this sense, they may be precisely those notions that form part of what Imai and Gentner (1997) call universal "ontological knowledge", and what Slobin (1985) considers to be the starting point for grammaticizable notions. The deaf children's gestural productions make it clear that children bring their own thoughts to the language-learning situation, and their gestures also provide us with an excellent tool for discovering those thoughts.

However, we have also seen that when children are exposed to a language model, that model has a dramatic effect on the way the children express and package their thoughts. Children learning English obey the patterns of their language and rarely omit words for figures or agents. Children learning Mandarin have more flexibility as their language permits, but does not demand, deletion. This flexibility allows the Chinese children's descriptions of motion events to resemble the deaf children's descriptions more closely than do the American hearing children's. The thoughts that these deaf children convey in their gestures thus appear to serve as a starting point and perhaps a default for all children as they begin the process of grammaticization – thoughts that have not yet been filtered through a language model.

Acknowledgements

This work was supported by Grant No. RO1 DC00491 from NIH to Goldin-Meadow,

and by a dissertation-writing fellowship from the Center for East Asian Studies at the University of Chicago to Zheng. We thank David McNeill, Terry Regier, Amanda Woodward, and John Lucy for their insightful thoughts about the study, Wataru Koyama for his help in coding the data, and Carolyn Mylander for making everything run smoothly.

References

Allen, S. E. M., & Schroder, H. (in press). Preferred argument structure in early Inuktitut spontaneous speech data. In J. D. DuBois, L. Kumpf, & W. Ashby (Eds.), *Preferred argument structure: grammar as architecture for function*. Amsterdam: Benjamins.

Aske, J. (1989). Path predicates in English and Spanish: a closer look. *Proceedings of the fifteenth annual meeting of the Berkeley Linguistics Society* (pp. 1–14). Berkeley, CA: Berkeley Linguistics Society.

Berman, R. A., & Slobin, D. I. (1994). *Relating events in narrative: a crosslinguistic developmental study*, Hillsdale, NJ: Erlbaum Associates.

Bloom, L., Miller, P., & Hood, L. (1975). Variation and reduction as aspects of competence in language development. In A. Pick, *The 1974 Minnesota symposium on child psychology*. Minneapolis: University of Minnesota Press.

Bloom, P. (1996). *Language and space*. Cambridge, MA: MIT Press.

Bowerman, M., & Choi, S. (2001). Shaping meaning for language: universal and language specific in the acquisition of spatial semantic categories. In M. Bowerman & S. C. Levinson (Eds.), *Language acquisition and conceptual development*. Cambridge: Cambridge University Press.

Choi, S., & Bowerman, M. (1991). Learning to express motion events in English and Korean: the influence of language-specific lexicalization patterns. *Cognition*, *43*, 83–121.

Clancy, P. (1993). Preferred argument structure in Korean acquisition. In E. Clark (Ed.), *The proceedings of the twenty-fifth annual child language research forum* (pp. 307–314). Stanford, CA: Center for the Study of Language and Information.

Dixon, R. M. W. (1979). Ergativity. *Language*, *55*, 59–138.

DuBois, J. W. (1987). The discourse basis of ergativity. *Language*, *63*, 805–855.

Feldman, H., Goldin-Meadow, S., & Gleitman, L. (1978). Beyond Herodotus: the creation of language by linguistically deprived deaf children. In A. Lock (Ed.), *Action, symbol, and gesture: the emergence of language* (pp. 351–414). New York: Academic Press.

Goldin-Meadow, S. (1979). Structure in a manual communication system developed without a conventional language model: language without a helping hand. In H. Whitaker & H. A. Whitaker (Ed.), *Studies in neurolinguistics*, Vol. 4. New York: Academic Press.

Goldin-Meadow, S. (1982). The resilience of recursion: a study of a communication system developed without a conventional language model. In E. Wanner & L. R. Gleitman (Eds.), *Language acquisition: the state of the art* (pp. 51–77). New York: Cambridge University Press.

Goldin-Meadow, S. (1985). Language development under atypical learning conditions: replication and implications of a study of deaf children of hearing parents. In K. Nelson (Ed.), *Children's language* (pp. 197–245). , 5. Hillsdale, NJ: Lawrence Erlbaum Associates.

Goldin-Meadow, S. (in press-a). *The resilience of language*. Philadelphia, PA: Psychology Press.

Goldin-Meadow, S. (in press-b). Thought before language: do we think ergative? In D. Gentner, & S. Goldin-Meadow (Eds.), *Language in mind: advances in the study of language and thought*. Cambridge, MA: MIT Press.

Goldin-Meadow, S., Butcher, C., Mylander, C., & Dodge, M. (1994). Nouns and verbs in a self-styled gesture system: what's in a name? *Cognitive Psychology*, *27*, 259–319.

Goldin-Meadow, S., & Feldman, H. (1977). The development of language-like communication without a language model. *Science*, *197*, 401–403.

Goldin-Meadow, S., McNeill, D., & Singleton, J. (1996). Silence is liberating: removing the handcuffs on grammatical expression in the manual modality. *Psychological Review*, *103*, 34–55.

Goldin-Meadow, S., & Mylander, C. (1983). Gestural communication in deaf children: non-effect of parental input on language development. *Science*, *221* (4608), 372–374.

Goldin-Meadow, S., & Mylander, C. (1984). Gestural communication in deaf children: the effects and non-effects of parental input on early language development. *Monographs of the Society for Research in Child Development*, *49*, 1–121.

Goldin-Meadow, S., & Mylander, C. (1998). Spontaneous sign systems created by deaf children in two cultures. *Nature*, *391*, 279–281.

Goldin-Meadow, S., Mylander, C., & Butcher, C. (1995). The resilience of combinatorial structure at the word level: morphology in self-styled gesture systems. *Cognition*, *56*, 195–262.

Goldin-Meadow, S., & Saltzman, J. (2000). The cultural bounds of maternal accommodation: how Chinese and American mothers communicate with deaf and hearing children. *Psychological Science*, *11*, 311–318.

Goldin-Meadow, S., Yalabik, E., & Gershkoff-Stowe, L. (2000). The resilience of ergative structure in language created by children and by adults. In S. C. Howell, S. A. Fish & T. Keith-Lucas (Eds.), *Proceedings of the 24th annual Boston University conference on language development* (pp. 343–353), Vol. 1. Somerville, MA: Cascadilla Press.

Goldin-Meadow, S., & Zheng, M. (1998). Thought before language: the expression of motion events prior to the impact of a conventional language model. In P. Carruthers & J. Boucher (Eds.), *Language and thought: interdisciplinary themes*. New York: Cambridge University Press.

Hashimoto, A. Y. (1971). The Mandarin syntactic structures. *Unicorn*, *8*, 1–149.

Hohenstein, J. M., Naigles, L. R., & Eisenberg, A. R. (in press). Keeping verb acquisition in motion: a comparison of English and Spanish. In G. Hall, & S. Waxman (Eds.), *Weaving a lexicon*. Cambridge, MA: MIT Press.

Huang, C. -T. (1984). On the distribution and reference of empty pronouns. *Linguistic Inquiry*, *15* (4), 531–574.

Hyams, N. (1986). *Language acquisition and the theory of parameters*. Dordrecht: Kluwer.

Imai, M., & Gentner, D. (1997). A cross-linguistic study of early word meaning: universal ontology and linguistic influence. *Cognition*, *62*, 162–200.

Jackendoff, R. (1991). Parts and boundaries. *Cognition*, *41*, 9–45.

Jackendoff, R., & Landau, B. (1991). Spatial language and spatial cognition. In D. J. Napoli & J. Kegl (Eds.), *Bridges between psychology and linguistics: a Swarthmore Festschrift for Lila Gleitman*. Hillsdale, NJ: Erlbaum.

Kretschmer, R. R., & Kretschmer, L. W. (1978). *Language development and intervention in the hearing impaired*, Baltimore, MD: University Park Press.

Levin, B., & Rappaport Hovav, M. (1991). The lexical semantics of verbs of motion: the perspective from unaccusativity. In I. Roca (Ed.), *Thematic structure: its role in grammar*. Berlin: Walter de Gruyter.

Levinson, S. (1983). *Pragmatics*. Cambridge: Cambridge University Press.

Lyons, J. (1977). *Semantics* (Vol. II, pp. 494, 720). Cambridge: Cambridge University Press.

Marschark, M. (1993). *Psychological development of deaf children*. New York: Oxford University Press.

McNeill, D. (1997a). *Imagery in motion event descriptions: gestures as part of thinking-for-speaking in three languages*. Paper presented at the twenty-third annual meeting of the Berkeley Linguistics Society, Berkeley, CA.

McNeill, D. (1997b, April). *Gesturing about manner*. Paper presented at the meeting of the Society for Research in Child Development, Washington, DC.

McNeill, D. (1998). Speech and gesture integration. In J. M. Iverson & S. Goldin-Meadow (Eds.), *The nature and functions of gesture in children's communications. New directions for child development, No. 79* (pp. 11–28). San Francisco, CA: Jossey-Bass.

McNeill, D. (2000). *One ontogenetic universal and several cross-linguistic differences in thinking for speaking*. Unpublished manuscript, University of Chicago, Chicago.

McNeill, D., & Duncan, S. (2000). Growth points in thinking-for-speaking. In D. McNeill, *Language and gesture* (pp. 141–161). Cambridge: Cambridge University Press.

Miller, G. A. (1972). English verbs of motion: a case study in semantics and lexical memory. In A. W. Melton & E. Martin (Eds.), *Coding processes in human memory*. Washington, DC: V.H. Winston.

Miller, G. A., & Johnson-Laird, P. N. (1976). *Language and perception*. Cambridge, MA: Harvard University Press.

Morford, J. P., & Goldin-Meadow, S. (1997). From here to there and now to then: the development of displaced reference in homesign and English. *Child Development*, *68*, 420–435.

Naigles, L. R., Eisenberg, A., & Kako, E. (1992). *Acquiring a language specific lexicon: motion verbs in English and Spanish*. Paper presented at the International Conference on Pragmatics, Antwerp, Belgium.

Ochs, E. (1982). Ergativity and word order in Samoan child language. *Language*, *58*, 646–671.

Phillips, S. B., Goldin-Meadow, S., & Miller, P. J. (2001). Enacting stories, seeing worlds: similarities and differences in the cross-cultural narrative development of linguistically isolated deaf children. *Human Development*, *44*, 311–336.

Pinon, C. J. (1993). *Paths and their names*. Paper presented at the meeting of the Chicago Linguistic Society, Chicago, IL.

Senghas, A., Ozyürek, A., & Kita, S. (2001). Encoding motion events in an emerging sign language: from Nicaraguan gestures to Nicaraguan signs. In A. Baker, B. van den Bogaerde & O. Crasborn (Eds.), *Cross-linguistic perspectives in sign language research. Selected papers from TISLR 2000*. Hamburg: Signum Press.

Silverstein, M. (1976). Hierarchy of features and ergativity. In R. M. W. Dixon (Eds.), *Grammatical categories in Australian languages* (pp. 112–171). Canberra: Australian Institute of Aboriginal Studies.

Slobin, D. I. (1985). Crosslinguistic evidence for the language-making capacity. In D. I. Slobin (Ed.), *Theoretical issues. The crosslinguistic study of language acquisition* (pp. 1157–1256), Vol. 2. Hillsdale, NJ: Erlbaum Associates.

Supalla, T. (1982). *Structure and acquisition of verbs of motion and location in American Sign Language*. Unpublished PhD dissertation, University of California, San Diego.

Supalla, T. (1990). Serial verbs of motion in ASL. In S. D. Fischer & P. Siple (Eds.), *Theoretical issues in sign language research* (pp. 127–152), Vol. 1. Chicago, IL: University of Chicago Press.

Svorou, S. (1994). *The grammar of space*. Philadelphia, PA: John Benjamins.

Talmy, L. (1985). Lexicalization patterns: semantic structure in lexical forms. In T. Shopen (Ed.), *Grammatical categories and the lexicon. Language typology and syntactic description* (pp. 57–149), Vol. III. New York: Cambridge University Press.

Talmy, L. (1991). Path to realization: a typology of event conflation. *Proceedings of the seventeenth annual meeting of the Berkeley Linguistics Society* (pp. 480–519). Berkeley, CA: Berkeley Linguistics Society.

Tsao, F. -f. (1990). *Sentence and clause structure in Chinese: a functional perspective*, Taipei: Student Book.

Valian, V. (1991). Syntactic subjects in the early speech of American and Italian children. *Cognition*, *40*, 21–81.

Wang, Q., Lillo-Martin, D., Best, C. T., & Levitt, A. (1992). Null subject versus null object: some evidence from the acquisition of Chinese and English. *Language Acquisition*, *2*, 221–254.

Zheng, M., & Goldin-Meadow, S. (1997). Lexical patterns in the expression of motion events in a self-styled gesture system. *Proceedings of the 21st annual Boston University conference on language development*, I–II. Somerville, MA: Cascadilla Press.