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# The Resilience of Structure Built Around the Predicate: Homesign Gesture Systems in Turkish and American Deaf Children

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Deaf children whose hearing losses prevent them from accessing spoken language and whose hearing parents have not exposed them to sign language develop gesture systems, called *homesigns*, which have many of the properties of natural language—the so-called resilient properties of language. We explored the resilience of structure built around the predicate—in particular, how manner and path are mapped onto the verb—in homesign systems developed by deaf children in Turkey and the United States. We also asked whether the Turkish homesigners exhibit sentence-level structures previously identified as resilient in American and Chinese homesigners. We found that the Turkish and American deaf children used not only the same production probability and ordering patterns to indicate who does what to whom, but also used the same segmentation and conflation patterns to package manner and path. The gestures that the hearing parents produced did not, for the most part, display the patterns found in the children's gestures. Although cospeech gesture may provide the building blocks for homesign, it does not provide the blueprint for these resilient properties of language.

In all cultures, the language-learning child is exposed to a model of a particular language and, not surprisingly, acquires that language. Thus, linguistic input clearly has an effect on the child's acquisition of language. Nevertheless, linguistic input does not affect all aspects of language development uniformly, and variations in linguistic input have been found to alter the course of development of some properties of language but not others (e.g., Newport, Gleitman, & Gleitman, 1977). Our focus here is on the properties that do not seem to depend on linguistic input, properties that Newport and colleagues (1977) call ''environment-insensitive'' and that we have called ''resilient'' (Goldin-Meadow, 1982, 2003). When the development of a linguistic property does not vary with variations in linguistic input, it could be because the property is truly

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insensitive to input. Alternatively, the property could be sensitive to input, but the amount and type of linguistic input that parents naturally give their children might be more than adequate for this particular property to develop. If so, we would be able to see the effects of linguistic input on this particular property only by removing the input children typically receive—that is, by observing children who do *not* have access to conventional linguistic input.

We cannot, of course, deliberately engineer such a situation. However, situations in which children cannot take advantage of the linguistic input to which they are exposed do exist. As an example, we have studied children whose hearing losses are so extensive that they cannot naturally acquire oral language, and whose hearing parents have not yet exposed them to a conventional manual language. These children are lacking access to a usable model of a natural language. Despite their impoverished language-learning conditions, the deaf children develop gestural communication systems, called *homesign*, which contain many—but not all—of the properties of language (Goldin-Meadow, 2003).

The properties that the children develop in their homesign gesture systems do not require linguistic input to be developed and, in this sense, are resilient. For example, homesign systems have been shown to exhibit morphological paradigms (Goldin-Meadow, Mylander, & Butcher, 1995; Goldin-Meadow, Mylander, & Franklin, 2007); the grammatical categories of noun, verb, adjective (Goldin-Meadow, Butcher, Mylander, & Dodge, 1994), and subject (Coppola & Newport, 2005); generic nouns (Goldin-Meadow, Gelman, & Mylander, 2005); constituent structure built around the noun (Hunsicker & Goldin-Meadow, 2012); surface markings that signal who does what to whom (Feldman, Goldin-Meadow, & Gleitman, 1978; Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1998); recursion (Goldin-Meadow, 1982); sentence-level negation and question operators (Franklin, Giannakidou, & Goldin-Meadow, 2011); and narrative structure (Phillips, Goldin-Meadow, & Miller, 2001).

Here we focus on an important aspect of linguistic structure that thus far has received very little attention: how motion events are packaged in the verb. We explore, in particular, how manner and path are mapped onto verbs in homesign. Senghas, Kita, and Özyürek (2004) showed that in the initial stage of a newly emerging sign language in Nicaragua, signers had two ways of expressing manner and path: separated into two signs (e.g., the signer would produce a sign conveying the manner in which a ball rolled down, followed by a sign for the trajectory, *roll-down*), or conflated within a single sign (e.g., the signer would produce the movement for the rolling manner while moving his hand in a downward trajectory, *roll* plus *down*). Over time, Nicaraguan Sign Language has evolved, and subsequent cohorts of signers are more likely to use the sequenced manner–path form than they are to use the conflated manner-plus-path form. These sequenced forms entered Nicaraguan Sign Language despite the fact that the gestures that hearing speakers produce in this community always conflate manner and path.

Established sign languages, such as American Sign Language (ASL), also display this same tendency, exhibiting constraints on the conditions when manner and path can be conflated within a single sign. For example, to describe a person limping in a circle, an ASL signer must first produce a sign for the manner, limp, followed by the sign for the path, circle; although it is physically possible to combine the two into a single sign, it is grammatically incorrect to do so (Supalla, 1990).

We ask here whether sequencing manner and path are characteristics of sign systems only when they have been created by groups of signers, or whether individual homesigners are able

to introduce this type of sequencing into the verb. Zheng and Goldin-Meadow (2002) examined how homesigners in the United States and China described crossing-space motion events and found that children in both cultures produced single gestures for path and manner and some gestures conflating path and manner. However, they did not examine combinations of verbs and thus did not ask whether the homesigners produced sequences of manner and path gestures.

We explore this question in four of the American homesigners who have been previously described (Goldin-Meadow & Mylander, 1998) and in four additional homesigners in another culture (Turkey). We chose Turkey as our culture of comparison because hearing speakers of Turkish and English have been shown to gesture differently when they talk about manner and path. Hearing Turkish speakers are more likely to produce sequences of manner and path gestures (e.g., fingers wiggling in place to indicate the walking manner, followed by a hand moving across space to indicate the path of the walk) in the gestures that accompany their speech, whereas hearing English speakers are more likely to conflate manner and path within a single cospeech gesture (e.g., fingers wiggling as the hand crosses space; Kita & Özyürek, 2003; Özyürek & Kita, 1999; Özyürek, Kita, Allen, Furman, & Brown, 2005). These gestural patterns can be traced to the typological difference between Turkish and English—manner and path tend to be expressed in two clauses in Turkish but in one clause in English. Our question is whether child homesigners introduce sequenced verbs for manner and path into their homesigns and, if so, whether Turkish homesigners, as a function of the gestural input they see, are more likely to sequence manner and path than are American homesigners.

In the event that we do find differences between the Turkish and American homesigners, it will be important to establish comparability between the groups on some other linguistic property. We therefore examine sentence-level structural properties found previously in the homesigns of the American deaf children. We look at the patterns of deletion and production of particular semantic elements (production probability patterns) and the order in which those semantic elements are produced (gesture-order patterns).

*Production probability patterns* describe the likelihood that a particular argument or predicate will be produced in a gesture sentence. In previous work, we found that both American and Chinese homesigners produce gestures for patients in a caused event, actors in a caused event, and actors in a spontaneous event at different rates (Feldman et al., 1978; Goldin-Meadow & Mylander, 1998): Gestures are produced significantly more often for caused-motion patients (the cheese when describing a mouse eating cheese) and for spontaneous-motion actors (the mouse when describing a mouse moving to its hole) compared with caused-motion actors (the mouse in a sentence describing a mouse eating cheese). This particular structural pattern is an analog of a structural case-marking pattern found in natural human languages—*ergative* languages, in which patients in caused events and actors in spontaneous events are marked in the same way and are both different from actors in caused events (cf. Dixon, 1979; Silverstein, 1976).

*Gesture-order patterns* describe where the gesture for a particular argument or predicate tends to appear in a sentence. We have found that in addition to reliably producing some semantic elements at the expense of others, American and Chinese homesigners were also consistent in where those elements were positioned in two-gesture sentences: They produced gestures for both patients in caused events and actors in spontaneous events before they produced gestures for acts (Goldin-Meadow & Mylander, 1998).

In sum, our study has three goals. First, we ask whether Turkish homesigners display systematic production probability and gesture-order patterns and, if so, whether the particular patterns they use resemble those previously found in American (and Chinese) homesigners. Second, we explore how Turkish versus American homesigners package manner and path gestures. Finally, we compare the gestures produced by Turkish and American homesigners to the gestures that their hearing mothers spontaneously produce when communicating with their children in a natural setting.

## METHOD

### Participants

We observed four children in Turkey (all in Istanbul)—two boys (Sina, Okan) and two girls (Nur, Rana)—and four children in the United States (one in Philadelphia, three in Chicago)—three boys (David, Marvin, Abe) and one girl (Karen[1]); data from the four American children have been previously described. All of the children were congenitally deaf with no recognized cognitive deficits. Each child had at least a 70-dB to 90-dB hearing loss in both ears, and the cause of deafness was unknown. It is extremely uncommon for deaf children with severe to profound hearing losses to acquire spoken language (Conrad, 1979; Mayberry, 1992; Meadow, 1968), and the children in our study were no exception. Despite the fact that many had hearing aids (although none had cochlear implants) and were receiving intensive oral instruction, none were able to acquire speech naturally. For example, at the time of our observations, none of the children could do more than produce an occasional spoken word in a highly constrained context, and none combined their spoken words into sentences.

Moreover, although deaf children who are exposed to a conventional sign language from birth are able to acquire that language as naturally as hearing children acquire a spoken language (Lillo-Martin, 1999; Newport & Meier, 1985), the deaf children in our study (like 90% of deaf children, Hoffmeister & Wilbur, 1980) were born to hearing parents who did not know a conventional sign language. In addition, the parents had decided to send their deaf children to an oral school that neither taught nor encouraged communication in the manual modality. Thus, the children in our study were unable to take advantage of the spoken language model that surrounded them and had not been exposed to a model of a conventional sign language.

The data for the Turkish deaf children came from two observation sessions of each child ($M_{age} = 4;2$; range = 3;7–4;7); the data for the American deaf children come from two observation sessions of each child ($M_{age} = 4;1$; range = 3;9–4;11). All of the children were videotaped at home for approximately 2 hr per session interacting with their hearing mothers and any other family members who were present, or with the experimenter who brought a standardized set of toys. In addition to analyzing the homesigners' gestures, we also coded and analyzed the spontaneous gestures that the children's hearing parents produced when communicating with their children.

[1]The children's names are pseudonyms. Karen was assigned the name Kathy in Goldin-Meadow et al. (1995, 2007).

## Coding Categories

*Isolating gestures and gesture sentences.* We used the coding system described in Goldin-Meadow and Mylander (1984) to isolate gestures from the stream of motor behavior, to describe the gestures, and to parse them into sentences. Gestures were coded along the three dimensions used to describe signs in conventional sign language: shape of the hand, location of the hand with respect to the body, and movement of the hand. A change in any one of these dimensions was taken to signal the end of one gesture and the beginning of another.

Motoric criteria were also used to determine the end of a string of gestures and thus sentence boundaries. Two gestures were considered to be separate sentences if the child paused or relaxed his hands between the gestures. Gestures that were not separated by pause or relaxation of the hands were considered part of the same sentence. The fact that homesigners' gesture strings display many of the properties found in the early sentences produced by hearing and deaf children learning a language from conventional models (Goldin-Meadow, 2003; Goldin-Meadow & Mylander, 1984) suggests that the units identified using these motor criteria are functioning like sentences. We therefore use the term *sentence* when describing the children's homesigns (although it is less clear that the term should be used when describing the hearing mother's gestures, we use it nevertheless to facilitate comparison).

*Assigning meaning to gestures.* Homesigners produce three different types of gestures: iconic gestures, deictic gestures, and markers. Markers are typically conventional gestures, such as flipping the palms from palm-down to palm-up to question, or shaking the head from side to side to negate. Markers are used to modulate sentences and are not included here in our structural analyses of propositions (see Franklin et al., 2011, for an analysis of negative markers and question markers in homesign). Deictic gestures refer to objects by pointing to, or holding up, the intended referent and can be used to refer to any entity that is present (and in some cases, entities that are not present; Butcher, Mylander, & Goldin-Meadow, 1991). Iconic gestures represent an aspect of an object or action through pantomime (e.g., the child moves two fists as though beating a drum, glossed as BEAT) or visual depiction (e.g., the child forms a circle with the thumb and index finger, glossed as ROUND). Using context and the form of the gesture, we identified all of the iconic action gestures that depicted crossing-space motion events and classified them as spontaneous motion (gestures depicting events in which the object or person moved across space on its own, e.g., *the ball rolls down*) or caused motion (gestures depicting events in which an object was moved across space, e.g., *he pushes the ball down*).

*Assigning meaning to sentence propositions.* In addition to assigning meanings to individual gestures, we also assigned propositional meanings to sentences. Once the boundaries of a gesture sentence were established using the motoric criteria described earlier, we determined how many propositions were conveyed within each sentence. Simple sentences contained one proposition; complex sentences contained two or more propositions.

We considered both the form of the gestures and the context in which the gestures were produced when assigning meanings to propositions (Goldin-Meadow & Mylander, 1984). The homesigners produced four types of propositions representing motion events. Two of the four types were caused-motion events: (1) one in which an actor moves a patient across space to an endpoint/recipient (*I move jar to table*, a three-place predicate, Column B in Table 1, e.g., point at jar–MOVE, or point at jar–point at table); note that the child did not have to produce

TABLE 1
The Database Used in Each Analysis of the Turkish and American Homesigners and Their Mothers[a]

| | | *Propositions in simple (One-proposition) sentences* | | | | | *Action propositions conveying crossing-space events in simple or complex sentences* | |
|---|---|---|---|---|---|---|---|---|
| | | *Action propositions* | | | | | | |
| | | *Caused motion* | | *Spontaneous motion* | | | | |
| *Group* | *Total gesture utterances* A | *Cross space three-place predicate (Ar-Pa-Re)*[b] B | *In place two-place predicate (Ar-Pa)* C | *Cross space two-place predicate (Ar-Re)* D | *In place one-place predicate (Ar)* E | *Static propositions* F | *Caused motion* G | *Spontaneous motion* H |
| Children | | | | | | | | |
| Turkish | 3,397 | 86 | 203 | 48 | 57 | 160 | 293 | 184 |
| American | 1,903 | 75 | 97 | 34 | 33 | 287 | 205 | 65 |
| Mothers | | | | | | | | |
| Turkish | 1,214 | 3 | 23 | 7 | 6 | 35 | 26 | 10 |
| American | 692 | 8 | 8 | 7 | 8 | 35 | 21 | 7 |

[a]The unit of analysis for Column A is the sentence, and the data come from complex sentences, simple sentences (including one-gesture sentences), and sentences containing only markers. The unit of analysis for Columns B through H is the proposition. The data in Columns B through F come from simple sentences that contain two or more gestures and convey action and/or static propositions. The data in Columns G and H come from simple and complex sentences containing at least one act gesture (either iconic or conventional) that conveys a crossing-space motion event.

[b]Ar = actor, Pa = patient, Re = recipient.

gestures for the all of the semantic elements within a predicate frame, or even a gesture for the predicate itself, for a sentence to be classified as conveying a three-place predicate (see Goldin-Meadow & Mylander, 1984, and Goldin-Meadow, 2003, for evidence validating our decision to code semantic elements that did not appear in the surface structure of the homesigners' gesture sentences); and (2) one in which an actor acts on a patient in place (*I open jar*, a two-place predicate, Column C in Table 1, e.g., point at jar–OPEN, or point at jar–point at self). The remaining two types were spontaneous-motion events: (3) one in which an actor moves on its own across space to an endpoint/recipient (*I go to table*, a two-place predicate, Column D in Table 1, e.g., point at self–GO, or point at self–point at table); and (4) one in which an actor moves on its own in place (*I dance*, a one-place predicate, Column E in Table 1, e.g., point at self–DANCE). In addition, the homesigners produced five types of propositions representing static events (Column F in Table 1): descriptive (*jar is big*, e.g., point at jar–BIG), locative (*jar belongs on shelf*, e.g., point at jar–point at shelf), possessive (*jar belongs to me*, e.g., point at jar–point at self), and two types of similarity: similarity between objects (*jar 1 resembles jar 2*, e.g., point at jar 1–point at jar 2) and similarity between an object and a picture (picture identification, *picture of jar resembles jar*, e.g., point at picture–point at jar).

Each gesture in a sentence was coded according to the semantic role its referent played in the proposition. For example, if a child pointed at a drum and then produced a BEAT gesture in

a context in which it was clear that he wanted his mother to act on the drum, the first gesture would be coded as a *patient* (the object of the action) and the second gesture would be coded as an *act* (the predicate). The sentence as a whole would be classified as conveying a two-place predicate (with the agent omitted) and would therefore be included in Column C in Table 1. This would contribute to our production probability and gesture-order analyses.[2]

We used context to decide whether a motion event was *caused* or *spontaneous*. For example, an event would be classified as caused if the child described someone twirling a dial, but as spontaneous if the child described a toy twirling on its own. For sentences describing crossing-space events (which were used in our path–manner analyses), it was at times necessary to use the form of the act gesture to decide whether a motion event was caused or spontaneous. Consider a crossing-space event in which a mother pushes a truck across the room and keeps her hand on the truck throughout the event; this is a caused-motion event no matter what form the child's act gesture takes (e.g., either a C-hand representing the mother's hand on the truck or a B-hand representing the truck itself as it is moved across space; both would be included in Column G in Table 1). However, if the mother gives the truck a push and it then moves across the room on its own, there are really two events taking place—a caused-motion event (*push*, which is not a crossing-space event and thus not included in our path–manner analyses) and a spontaneous-motion event (*move*, which is a crossing-space event and thus part of our path–manner analyses). For events of this type, we used gesture form as a guide to the child's intended meaning. The child's gesture sentence would be considered caused if he produced a *push* gesture (a C-hand representing the mother's hand on the truck as she initiated its move across space), but it would be considered spontaneous if he produced a *move* gesture (a flat palm representing the truck moving across space. The *move* gesture would be included in Column H in Table 1; the *push* gesture would not be included in Column G because it does not convey a crossing-space event.

Deciding how the verb in a sentence should be characterized had implications for the semantic roles attributed to the gestures conveying arguments in the sentence. In describing an event in which a mother pushes a truck that then moves on its own (a caused-in-place event that initiates a spontaneous crossing-space event), if the child produced a pointing gesture at the truck along with a *push* gesture, the point would be classified as a patient in a caused event (i.e., *mother push truck*). In contrast, if the child produced a pointing gesture at the truck with a *move* gesture, the point would be classified as an actor in a spontaneous event (i.e., *truck move there*). This decision was made without attention to the order in which the gestures were produced; that is, the pointing gesture would be classified as a patient whether the child produced it before (*truck push*) or after (*push truck*) the *push* gesture. In contrast, in describing an event in which a mother continuously pushes the truck across the floor (a continuously caused crossing-space event), a pointing gesture at the truck would be considered a patient whether the point was produced with a *push* gesture (*mother push truck there*, with manner specified but not path), with a *move* gesture (*mother move truck there*, with path specified but not manner), or with a push-forward gesture (*mother push-forward truck there*, with manner and path specified in a single, conflated gesture; see classifying gestures and gesture sentences conveying cross-space motion events).

[2]Although the point at drum–BEAT sentence conveys a caused motion, this gesture sentence would *not* be included in Column G in Table 1 because it does not convey a crossing-space event and is thus not relevant to our path–manner analyses.

*Classifying gestures and gesture sentences conveying crossing-space motion events.* We first classified each action gesture conveying a crossing-space event (in-place action gestures were excluded from this analysis). We used the form of the crossing-space act gesture to classify it as either manner and/or path.

Gestures conveying spontaneous motion were divided into three categories: *Path* gestures depicted the trajectory that the moving object took (e.g., descending movement of the hand, representing moving *down*). *Manner* gestures depicted motions that could potentially occur simultaneously with the path, typically the means by which the object moved as it changed its location (e.g., repetitive circular movement, representing *roll*). *Manner*-plus-*path* gestures simultaneously depicted both manner and path (e.g., hand moves repetitively in a circle as it descends, representing *roll down*).

Gestures conveying caused motion were divided into the same three categories: *Path* gestures depicted the trajectory that the object followed as it was moved (e.g., a hand in a neutral pointing shape moves sideways, representing moving *across*). *Manner* gestures depicted the shape of the hand on the object as it was moved (e.g., a hand cupped as though pushing a truck, held in place with no movement, representing *push*). *Manner*-plus-*path* gestures simultaneously depicted both manner and path (e.g., a cupped hand moves sideways as though pushing a truck across the room, representing *push across*). Note that previous studies in both spoken (e.g., Papafragou, Massey, & Gleitman, 2006; Slobin, 1996) and signed (e.g., Supalla, 1990) languages have focused on manner and path in *spontaneous*-motion events (but see Furman, Özyürek, & Allen, 2006). Here we broaden the scope to include manner and path in *caused*- as well as spontaneous-motion events.

Finally, we classified sentences that contained crossing-space act gestures, both caused and spontaneous, according to the types of manner and path gestures expressed in the sentence: 1) *path* alone (no gestures referring to manner, although the sentence could contain gestures referring to other semantic elements); 2) *manner* alone (no gestures referring to path); 3) *conflated* (a manner-plus-path gesture with no other gestures referring to manner or path); 4) *sequenced* (at least one manner and one path gesture and no manner-plus-path gestures); or 5) *mixed* (a manner-plus-path gesture combined with a manner and/or a path gesture).

*Coding hearing mothers' gestures.* We used the same procedures and categories to identify, segment, and classify the cospeech gestures that the deaf children's hearing parents produced. We tried to code the hearing parents' gestures from the deaf child's point of view and thus did not rely on the parents' speech when making our coding decisions. Indeed, whenever possible, we coded mothers' gestures with the sound turned off. We thus did *not* use speech boundaries when determining the beginnings and ends of gesture sentences and used instead the same motoric criteria that we applied to the children's gestures.

*Reliability.* The American data were coded by native English speakers; some of the Turkish data were coded by native Turkish speakers who were bilingual in English, and some were coded by native English speakers. Reliability was determined by having two independent coders transcribe a portion of the videotapes, and was conducted between a native English speaker and a Turkish-English bilingual speaker. Agreement between coders was 91% for the U.S. homesigners and 81% for the Turkish homesigners for isolating gestures from the stream of motor behavior; 95% and 93%, respectively, for determining boundaries between sentences; 94% and 88%, respectively, for assigning meaning to action gestures; 94% and 85%, respectively,

for classifying sentences according to proposition type; and 97% and 87%, respectively, for classifying individual gestures according to semantic role. Comparable numbers ranged between 94% and 100% for the U.S. mothers and between 86% and 96% for the Turkish mothers. Disagreements were decided by discussion; in the event that consensus could not be reached, the gesture was considered ambiguous and was eliminated from the analyses.

## RESULTS

The Turkish homesigners produced a total of 7,627 gestures in 3,397 gesture sentences, compared with the American homesigners who produced 3,540 gestures in 1,903 gesture sentences. Gesture sentences were classified into four categories: simple sentences (containing at least two gestures conveying a single proposition); complex sentences (containing at least two gestures conveying more than one proposition[3]); single-gesture sentences (containing a deictic or iconic gesture produced on its own or with a marker); and marker sentences (containing only marker gestures). All data were used in the analyses of gesture rate; simple sentences were used in the analyses of sentence-level devices indicating who does what to whom (i.e., gesture production probability [Figures 1 and 3] and gesture order); simple, complex, and single-gesture sentences containing at least one crossing-space act gesture were used in the analyses of how manner and path are packaged in expressions of crossing-space motion events (Figures 2 and 4). Table 1 presents the database used for each analysis: gesture rate (Column A), types of propositions in simple sentences (Columns B through F), gesture production probability (Columns C and D), gesture order (Columns B through E), and manner and path in all sentences containing crossing-space motion events (Columns G and H).

### Gesture Rate and Types of Propositions

Before examining the structural properties of the children's homesigns, we look at the rate at which the children gestured and the types of propositions they expressed in their gesture systems to ensure that they were using their homesigns in comparable ways. We found that the Turkish homesigners produced twice as many gestures per hour ($M = 392.3$, $SD = 142.2$) as did the American homesigners ($M = 187.5$, $SD = 113.8$), $t = 2.25$, $df = 6$, $p = .03$.

Despite the fact that the two groups of children gestured at different rates, the types of propositions they conveyed in their simple sentences were comparable. The Turkish children produced a mean number of 98.5 ($SD = 41.6$) action propositions and 71.2 ($SD = 27.3$) static propositions; the comparable numbers for the American children were 59.7 ($SD = 44.0$) and 40.0 ($SD = 37.5$). Thus, both groups produced more sentences conveying action propositions than static propositions: Turkish, .58 ($SD = .02$) versus .42 ($SD = .02$), respectively; American, .63 ($SD = .04$) versus .37 ($SD = .04$). All of the Turkish and American children conveyed at least one instance of the four types of action propositions (the two crossing-space actions and the two in-place actions) in their simple sentences. In addition, with two exceptions, the Turkish and American children conveyed at least one instance of the five types of static propositions

[3]A complex sentence could contain as few as two gestures, one conveying one proposition and another conveying a second proposition.

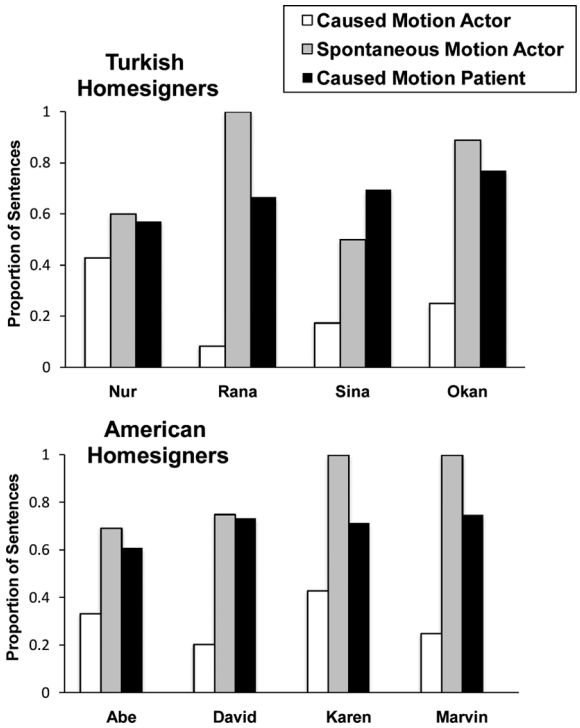


FIGURE 1 The probability that a Turkish (top) or American (bottom) homesigner will produce gestures for the caused-motion actor (white bars), spontaneous-motion actor (black bars), or caused-motion patient (gray bars) in gesture sentences conveying two of three possible semantic elements (i.e., two-gesture sentences conveying two-place predicates). Both Turkish and American homesigners treat the spontaneous-motion actor like the patient and not like the caused-motion actor and, in this sense, display an ergative pattern.

(description, location, possession, similarity, and picture identification) in their gesture sentences—one Turkish child produced no possessive static propositions, and one Turkish child produced no picture identification propositions. We focus our structural analyses on the action sentences (Columns B through E in Table 1).

## Sentence-Level Structure: Marking Who Does What to Whom by Deletion and Order

*Gesture production and deletion regularities.* Production probability patterns describe the likelihood that a particular argument or predicate will be produced in a gesture sentence. For example, when describing a mouse eating cheese, a caused-motion event, the homesigner could produce a gesture for the actor (mouse), the act (eat), or the patient (cheese). In a sentence that contains only two gestures, it is not possible to produce gestures for all three semantic elements. Production probability is a measure of which elements are likely to be gestured and which are likely to be omitted. We restricted our analysis to propositions that have three possible

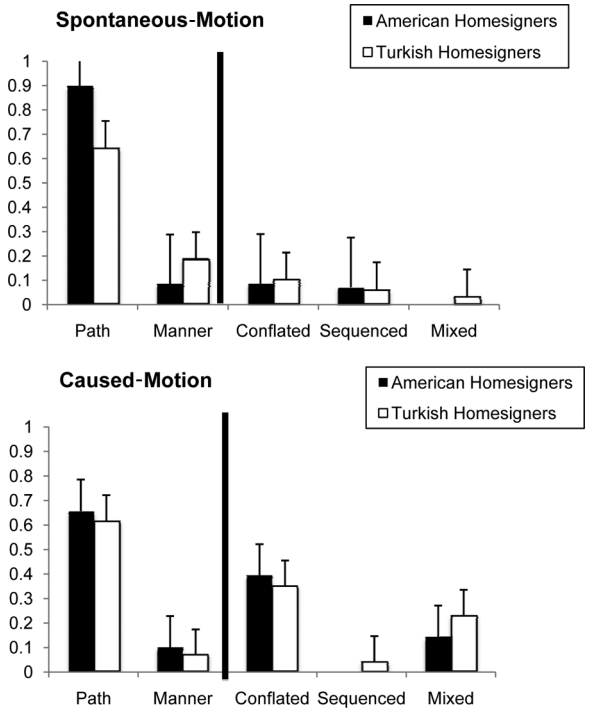


FIGURE 2 The proportion of gesture sentences produced by American (black bars) and Turkish (white bars) homesigners to describe spontaneous- (top) and caused- (bottom) motion events, categorized according to how manner and path were packaged in the sentence (*path, manner, conflated, sequenced*, or *mixed* forms). The error bars indicate standard errors.

semantic elements, that is, to two-place predicates: the actor, act, and patient in caused-motion sentences (Column C, Table 1); and the actor, act, and recipient/endpoint in spontaneous-motion sentences (Column D, Table 1); we considered only those sentences containing gestures for two of the three possible semantic elements within a proposition (i.e., we eliminate the small number of simple sentences the children produced containing three or more gestures). The data for the American children were reported in Goldin-Meadow and Mylander (1998).[4]

We analyzed the relevant action sentences—a subset of the sentences in Columns C and D in Table 1 (two-gesture sentences conveying two-place predicates, both caused [$x$ acts on $y$] and spontaneous [$x$ moves to $y$])—that the Turkish homesigners produced ($N = 158$), and we compared them to the American data ($N = 78$; see Figure 1). After subjecting the proportional data to an arcsine transform, we conducted an analysis of variance (ANOVA) with one between-subjects factor (culture: Turkish vs. American) and one within-subjects factor (semantic element: caused-motion actor, spontaneous-motion actor, caused-motion patient) and found a significant effect of semantic element, $F(2,\ 12) = 17.04$, $p < .0001$, $\eta^2 = .66$, no effect of

[4]In our previous analyses of sentence-level structures (Goldin-Meadow & Mylander, 1984, 1998), we focused exclusively on simple sentences containing one proposition; sentences containing two or more verbs were therefore eliminated from those analyses. To have comparable data for the Turkish homesigners, we followed that same practice here.

culture, $F(1, 6) = 1.16$, $p = .32$, and no interaction, $F < 1$. Tukey honest significant difference (HSD) comparisons revealed that the production probability for caused-motion actors was different from the production probability for spontaneous-motion actors ($p < .01$) and for caused-motion patients ($p < .01$), and that the production probability for spontaneous-motion actors and caused-motion patients did not differ. Both Turkish and American homesigners were more likely to omit a gesture for the caused-motion actor than for the spontaneous-motion actor or for the caused-motion patient.[5]

This pattern is an analog of an ergative case-marking pattern (cf. Dixon, 1979; Silverstein, 1976). The hallmark of the ergative pattern is that actors in intransitive sentences expressing spontaneous motions are treated more like patients than like actors in transitive sentences expressing caused motions, as was the case in the deaf children's production and deletion patterns: Gestures for the spontaneous-motion actor (the moving mouse) tended to be produced as often as gestures for the caused-motion patient (the eaten cheese) and more often than gestures for the caused-motion actor (the eating mouse).

*Gesture-order regularities.* Gesture-order patterns describe where the gesture for a particular argument or predicate tends to appear in a sentence. We analyzed the relevant two-gesture action sentences—a subset of the sentences in Columns B through E in Table 1 (all simple action sentences containing two gestures)—that the Turkish children produced and compared them to the American data. We looked, in particular, at sentences containing gestures for caused-motion patients and acts, and at sentences containing gestures for spontaneous-motion actors and acts. The data for the American children were reported in Goldin-Meadow and Mylander (1998).

Children in both cultures placed gestures for patients before gestures for acts (cheese-eat): Nur produced 11 of 11 relevant sentences conforming to this pattern, Rana produced 22 of 23, Sina produced 54 of 63, Okan produced 36 of 39, Marvin produced 9 of 10, Abe produced 9 of 14, and Karen produced 4 of 4 ($p$s $\leq .02$, binomial test on each child, for all children except Abe and Karen); David's data were an exception to the pattern—17 of 35. The children also produced gestures for spontaneous-motion actors before they produced gestures for acts (mouse-go): Rana produced 12 of 12, Okan produced 18 of 20, Abe produced 10 of 10, David produced 18 of 23, Nur produced 8 of 11, Sina produced 9 of 12, Marvin produced 4 of 4, Karen produced 2 of 3 ($p$s $\leq .01$, for all children except Nur, Sina, Marvin, and Karen). In other words, both Turkish and American children placed spontaneous-motion actors in the same position as caused-motion patients, a pattern again consistent with an ergative structure.

Thus, like the American homesigners, the Turkish homesigners produced and positioned their gestures in sentences as a function of the semantic role the gesture represented and, in this sense, displayed a simple syntax. Moreover, the particular syntactic patterns found in the homesign systems in both cultures were the same.

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[5]If actor production is sensitive to the number of arguments posited in underlying structure, it should be lower in three-place caused-motion predicates than in two-place caused-motion predicates, as it was for both Turkish (.10 vs. .23) and American (.00 vs. .33) homesigners. Similarly, actor production was lower in two-place spontaneous-motion predicates than in one-place spontaneous-motion predicates, again for both Turkish (.86 vs. 1.00) and American (.75 vs. 1.00) homesigners. In each analysis, the act was hypothesized to occupy a separate slot in underlying structure (i.e., there were four possible slots in a three-place predicate [act, actor, patient recipient]), and its production probability followed the same patterns found for the other semantic elements (i.e., for the arguments). See Goldin-Meadow (1982, 1985) and Goldin-Meadow and Mylander (1984) for further discussion of underlying predicate frames in homesign.

## Building Structure Around the Predicate: Packaging Manner and Path

Thus far, we have found that despite differences in the numbers of gestures produced by the Turkish and American homesigners, the sentence-level structures that the children in both cultures display are nearly identical and consistent with previous cross-cultural comparisons. These similarities provide an opportunity to more directly compare how manner and path are packaged by Turkish and American homesigners. The unit of analysis that we used for this analysis was the proposition. Simple sentences, by definition, convey only one proposition. In previous analyses, we considered any sentence that contained two-act gestures to be a complex, two-proposition (i.e., two-verb) sentence, even if the gestures conveyed two aspects of the same event (i.e., even if one gesture conveyed the manner and the other conveyed the path of the same crossing-space event). In the current analysis, we included all sentences containing act gestures that conveyed a crossing-space event, whether it was a simple or a complex sentence. In addition, some complex sentences conveyed more than one crossing-space motion event. The numbers displayed in Columns G through H in Table 1 include all propositions conveying crossing-space motion events, some of which were produced within the same, complex sentence.

The Turkish homesigners produced an average of 50.25 ($SD = 13.89$) crossing-space propositions containing act gestures that conveyed spontaneous motion and produced an average of 65.0 ($SD = 30.4$) that conveyed caused motion; the comparable numbers for the American homesigners were 18.25 ($SD = 17.46$) and 51.5 ($SD = 36.37$), respectively. Both groups thus produced more crossing-space propositions for caused motion than for spontaneous motion. Both groups also used a relatively large number of conventional emblems (rather than iconic gestures representing manner or path) to convey caused-motion crossing-space events. Conventional emblems are gestures used by hearing speakers that have a fixed form; for example, the GIVE gesture is made with an open palm, held up, and is often extended toward the object; the MOVE gesture is made with an open palm, held up, and the fingers flicked into the palm as though beckoning. The American children used these GIVE and MOVE gestures in 85% of their caused-motion crossing-space propositions; the Turkish children used them in 70% of their caused-motion propositions. Both groups used conventional gestures for spontaneous motion (e.g., COME: open hand, palm up, fingers flap back and forth toward the body, used by the American children; and GO: downward open hand moving back and forth used by the Turkish children), but they used these emblems far less often than they used the caused-motion emblems (1% of their spontaneous-motion crossing-space propositions contained emblems in the American children, 4% in the Turkish children). We focused our analyses on propositions containing iconic gestures simply because the form of a conventional emblem does not iconically depict either the path or the manner of the motion.

The top graph in Figure 2 presents the data for crossing-space sentences conveying spontaneous motion in the Turkish and American homesigners, and the bottom graph presents comparable data for caused motion in the two groups. In sentences conveying spontaneous crossing-space events, both the Turkish and American homesigners primarily produced *path*-alone gestures and a few produced *manner*-alone gestures (bars to the left of the line in each graph). Both groups also produced some sentences containing both path and manner gestures (bars to the right of the line). When the Turkish children expressed both manner and path in a single sentence, they produced instances of all three types of combinations—*conflated, sequenced*, and *mixed*. All of the American children produced *conflated* forms; one American

child produced *sequenced* forms; and in this dataset, no American children produced the *mixed* form for spontaneous crossing-space motion events. The pattern for *caused* crossing-space events was similar. Both groups again produced more *path*-alone gestures than *manner*-alone gestures (bars to the left of the line). Again, the Turkish children produced all three types of manner-plus-path combinations—*conflated, sequenced*, and *mixed*—and the American children produced only two—this time, *conflated* and *mixed*.

Note that conflating manner and path in a caused-motion event amounts to incorporating a hand shape that depicts the manner in which the object was held into a path gesture that depicts the trajectory the hand followed as it moved the object from one location to another (e.g., a palm-up grasp moving along a horizontal path, *carry* plus *to*). This gesture thus mimics the actual motion that would be used to relocate the object, and in this sense, it is a more veridical representation of the event than any of the other gesture forms. However, all five of the children who produced the *conflated* form for caused motion also produced *path*-alone gestures for caused motion (i.e., with a neutral hand shape rather than a *manner* hand shape), suggesting that they were able to separate the manner and path segments that appeared in a conflated form. Moreover, the four American homesigners (on whom we have early developmental data) all produced their first *path*-plus-*manner* form for caused motion after the age that had been determined (based on other criteria; see Goldin-Meadow et al., 1995) as the onset of morphological structure in each child's gesture system. Prior to the onset of morphological structure, the children produced *path*-alone gestures (with a neutral hand shape) and thus were able to convey caused motion but did so using the *less* mimetic form. The form that mirrored the actual movement was a relatively late acquisition, suggesting that when the children used the conflated *path*-plus-*manner* form to communicate about caused motion, they were not merely imitating the action used to move the object.

The *mixed* form contained a *conflated* gesture, combined with either a *path* or *manner* gesture. Three of the four Turkish children (Nur, Sina, and Okan) produced the *mixed* form when conveying spontaneous motions, and the fourth child (Rana) produced the *mixed* form for caused motions. In contrast, only one American child (David) produced a *mixed* form, and only when conveying caused motions. As an example of a *conflated* gesture plus a *path* gesture, to describe falling rain, Okan first moved his hand down (*path*) and then moved his hand down again, this time wiggling his fingers (*path*-plus-*manner*). As an example of a *conflated* gesture plus a *manner* gesture, to describe a firefighter moving a hose, Rana held a fist in place (*manner* gesture) and then moved the fist in an arc (*path*-plus-*manner*). Although most of the *mixed* sentences that the children produced followed this pattern—*path* or *manner* followed by *path*-plus-*manner*—at times, the gestures were reversed; for example, to describe a moving spider, Nur first wiggled her fingers while moving her hand forward (*path*-plus-*manner*) and then wiggled her fingers in place (*manner*).[6] The children's *mixed* forms thus reflected a variety of ways to combine manner and path, but they all had in common that one component of the conflated gesture was abstracted out and produced along with it.

To summarize, the distribution of forms that the children in the two groups used overall was comparable (see Figure 2). Thus, contrary to our expectations that the homesigners' gestures for

[6]It is possible that in this example, the child was using her wiggling fingers produced in place to represent the spider, rather than the *manner* in which the spider moved. Note, however, that iconic gestures were included in our manner/path analyses only if the child used them as verbs and not as nouns (see Goldin-Meadow et al., 1994, for a description of the criteria used to distinguish nouns from verbs in homesign).

manner and path might differ as a function of the gestures produced by hearing speakers in their cultures, we found that the Turkish homesigners produced gestures for paths and manners in roughly the same distribution as the American homesigners, although the Turkish children displayed more and different varieties of manner-path-plus combinations. However, it is possible that the differences found in the cospeech gestures of Turkish versus English speakers do not appear in talk to children, particularly young deaf children. We explore this possibility and the possibility that the deaf children's hearing parents' gestures served as a model for all of the patterns we have found in the deaf children's homesigns in the next section.

## The Gestures Produced by the Homesigners' Hearing Parents

*Gesture rate.* We begin by examining gesture rate in the homesigners' hearing parents. Interestingly, we found that the mothers of the Turkish homesigners produced more gesture sentences per hour than did the mothers of the American homesigners (329.5 [$SD = 183.2$] vs. 281.8 [$SD = 153.1$]), a pattern also found in the children. Indeed, in an ANOVA with one between-subjects factor (culture: Turkish, American) and one within-subjects factor (dyad: child, mother), we found a significant effect of culture, $F(1, 6) = 6.40$, $p < .05$, $\eta^2 = .47$, but no effect of dyad, $F < 1$, and no interaction, $F < 1$. The Turkish mothers and children gestured more than did the American mothers and children.

When we looked at the types of gesture constructions that the mothers used, we found that very few were multigesture sentences: only 0.08 ($SD = 0.04$) for the Turkish mothers and 0.15 ($SD = 0.03$) for the American mothers compared with 0.35 ($SD = 0.09$) and 0.35 ($SD = 0.07$) for the Turkish and American children, respectively. In an ANOVA with one between-subjects factor (culture: Turkish, American) and one within-subjects factor (dyad: child, mother), we found a significant effect of dyad, $F(1, 6) = 31.12$, $p < .01$, $\eta^2 = .75$, no effect of culture, $F(1, 6) = 2.94$, $p = .14$, and no interaction, $F(1, 6) = 2.55$, $p = .16$. Note that this difference was not a function of the total number of gestures the mothers produced, as at least the Turkish mothers produced a relatively large number of gestures (Column A, Table 1). The difference reflects how the parents used their gestures. The mothers produced many gesture sentences containing a single gesture (typically a pointing gesture) or a single marker (e.g., nod or headshake). In contrast, when the children produced markers, they often combined them with either pointing or iconic gestures (see Franklin et al., 2011). The paucity of gesture combinations makes it difficult for us to detect patterns in the mothers' data, but it also presents a problem for the children—if the children are to use their mothers' gestures as a model for their own gestures, they too are going to have to make generalizations from small amounts of data.

*Proposition types.* In terms of types of propositions, the mothers conveyed many, but not all, of the 9 propositions that the homesigners conveyed in their simple gesture sentences. On average, the Turkish mothers conveyed 6.5 ($SD = 1.3$) of the 9 types of propositions and the American mothers conveyed 7.0 ($SD = 2.2$) compared with their children (8.5 [$SD = 0.6$] for the Turkish children; and 9.0 [$SD = 0$] for the American children). The mothers produced most of the action propositions; four mothers (three Turkish, one American) each omitted 1 action proposition. But the mothers failed to produce many of the static propositions: Six mothers (three Turkish, three American) did not convey possession, five did not convey location (two

Turkish, three American), three did not convey picture identification (one Turkish, two American), two did not convey description (one Turkish, one American), and one Turkish mother did not convey similarity. Thus, the mothers and children used their gestures to convey roughly the same types of propositions, but the children covered a wider range of relations (particularly static relations) than did their mothers.

*Gesture production and deletion regularities.* We next examined production probability patterns in the mothers' gesture sentences conveying action propositions (see the graphs on the right in Figure 3). We asked first whether the mothers' production probability patterns differed across cultures. After applying an arcsine transform to the proportional data, we conducted an ANOVA with one between-subjects factor (culture: Turkish, American) and one within-subjects factor (semantic element: caused-motion actor, spontaneous-motion actor, caused-motion patient) on the mothers' data and found a significant effect of semantic element, $F(2, 12) = 6.38$, $p < .05$, $\eta^2 = .30$, but no effect of culture, $F < 1$, and no interaction, $F(2, 12) = 1.28$, $p = .31$. We thus found no differences in the structural arrangement of the gestures between the Turkish and American hearing mothers.

However, the mothers' production probability patterns differed from those of their children. Figure 3 presents grouped data for both mothers and children in the two cultures. We collapsed

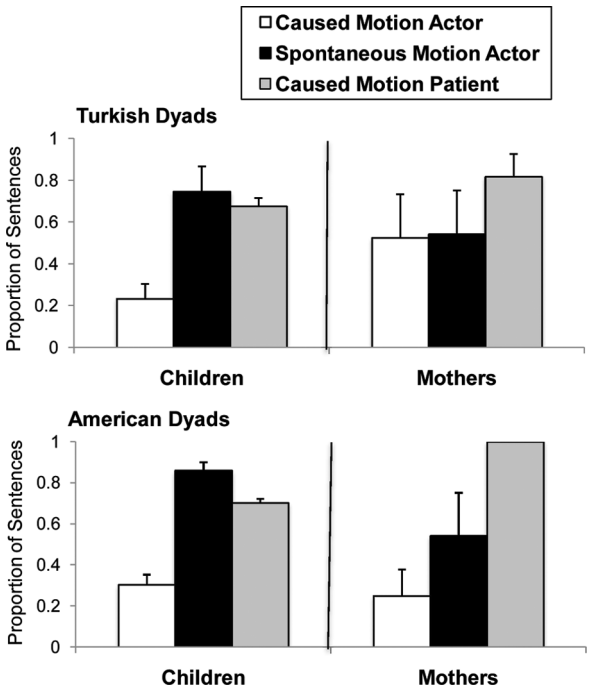


FIGURE 3 The probability that the Turkish homesigners and their hearing mothers (top) and the American homesigners and their hearing mothers (bottom) will produce gestures for the caused-motion actor (white bars), spontaneous-motion actor (black bars), or caused-motion patient (gray bars) in gesture sentences conveying two of three possible semantic elements (i.e., two-gesture sentences conveying two-place predicates). The children in both cultures displayed an ergative pattern in their gestures; the mothers did not. The error bars indicate standard errors.

across culture and conducted an ANOVA with one between-subjects factor (dyad: child, mother) and one within-subjects factor (semantic element: caused-motion actor, spontaneous-motion actor, caused-motion patient) and found a main effect of semantic element, $F(2, 35) = 8.94$, $p < .001$, $\eta^2 = .27$, no main effect of dyad, $F < 1$, but a significant interaction, $F(2, 35) = 3.59$, $p < .05$, $\eta^2 = .11$, indicating that the production probability patterns were different for mother and child. Although both mothers and children produced fewer gestures for caused-motion actors than for patients ($ps < .05$), it is where spontaneous-motion actors are situated relative to caused-motion actors and patients that determines the typology of a language—and here is where mothers and children differed. The mothers' production probability for spontaneous-motion actors was no different from their production probability for caused-motion actors or for caused-motion patients. In contrast, children in both cultures produced spontaneous-motion actors at a rate that was significantly different from caused-motion actors ($p < .01$) but not different from caused-motion patients, thus displaying an ergative pattern.

*Gesture-order regularities.* We found that mothers in both cultures produced very few gesture sentences that we could analyze for order, although the few sentences that they did produce were not different across cultures and also, for the most part, were not different from those of their children. All four of the Turkish mothers and three of the American mothers placed gestures for patients before gestures for acts: Okan's mother produced 9 of 10 relevant sentences conforming to this pattern, Nur's mother produced 3 of 4, Rana's mother produced 1 of 1, Sina's mother produced 2 of 2, Abe's mother produced 1 of 1, David's mother produced 2 of 2, Mike's mother produced 4 of 5 (the pattern was statistically significant only for Okan's mother, $p = .02$, binomial test); the one exception was Karen's mother—1 of 2. All of the mothers who produced sentences containing spontaneous-motion actors and acts placed gestures for spontaneous-motion actors before gestures for acts, although again the numbers were very small (too small to test for statistical significance): All four of the Turkish mothers produced 1 of 1 relevant sentence conforming to this pattern, Abe and Marvin's mothers produced 3 of 3, and David's mother produced 2 of 2.

*Packaging manner and path.* Unlike their children, the hearing mothers produced fewer crossing-space propositions containing act gestures that conveyed caused motion compared with those that conveyed spontaneous motion: $M = 5.0$ ($SD = 1.8$) vs. $M = 7.25$ ($SD = 3.9$) for the Turkish mothers; $M = 3.3$ ($SD = 2.1$) vs. $M = 6.5$ ($SD = 4.9$) for the American mothers. They used the same conventional gestures as did their children, but they used them relatively infrequently: an average of 0.52 ($SD = 0.35$) of the Turkish mothers' caused-motion propositions and an average of 0.47 ($SD = 0.32$) of their spontaneous-motion propositions; the comparable numbers for the American mothers were 0.52 ($SD = 0.45$) for caused motion and 0.52 ($SD = 0.30$) for spontaneous motion.

Because the mothers produced so few crossing-space gesture propositions overall, we tabulated the number of mothers who produced each type of gesture form in the two groups and compared that number to the number of children who produced that form. Figure 4 presents the data for spontaneous and caused motion combined.

Looking at Figure 4, we see that three Turkish mothers (Nur's, Sina's, and Okan's mothers) produced *path* forms, and two (Nur's and Rana's mothers) produced *manner* forms. In addition, the Turkish mothers produced a few forms combining manner and path: Nur's mother produced

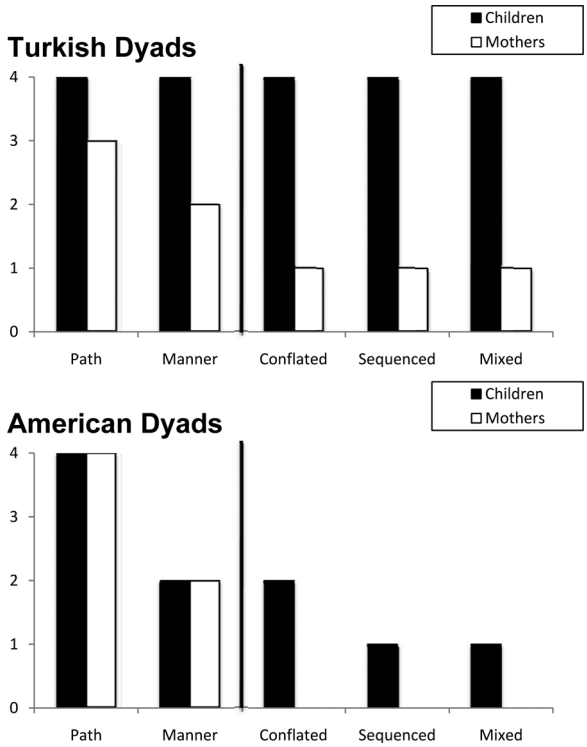


FIGURE 4 The number of homesigners (black bars) and their mothers (white bars) in Turkey (top) and the United States (bottom) who produced gesture sentences containing *path, manner, conflated, sequenced*, and *mixed* forms when describing spontaneous- or caused-motion events. The children in both cultures used a wider variety of forms than did the mothers.

the *conflated* form, Rana's mother produced the *sequenced* form, and Okan's mother produced the *mixed* form. In contrast, although all four American mothers produced *path* forms and two (Abe's and Marvin's mothers) produced *manner* forms, none of the American mothers produced forms combining manner and path. Thus, as a group, the American mothers produced a narrower variety of forms than did the Turkish mothers—and their children followed suit. All four of the American children produced *path* forms, two produced *manner* forms (Abe and David), and the same two produced the *conflated* form. David was the only American child who produced the *mixed* form. In contrast, all four of the Turkish children produced all five forms—*path, manner, conflated, sequenced, mixed*.

However, it is important to note that in both groups, the children went beyond the input they received. All four Turkish children produced forms not found in their mothers' gestures: Nur produced *sequenced* and *mixed* forms; Sina produced *manner, conflated, sequenced*, and *mixed* forms; Rana produced *path, conflated*, and *mixed* forms; and Okan produced *manner, conflated*, and *sequenced* forms—all not found in their respective mother's gestures. In the American group, David produced *manner, conflated, sequenced*, and *mixed* forms, and Abe produced *conflated* forms, all not found in their respective mother's gestures. Only one mother produced a form that could not be found in her child's gestures: Marvin's mother produced the *manner*

form, and Marvin did not. Thus, all but two of the children (Marvin and Karen) not only produced the forms they saw in their input, but also produced forms that they did not see.

## DISCUSSION

Our goal was to compare the homesigns developed by deaf children in two cultures, Turkish and American, while focusing on sentence-level structure (marking who does what to whom) and structure built around the predicate (how manner and path are packaged). We also explored whether the structures found in the children's gestures could be traced to the cospeech gestures produced by the children's hearing mothers. We found that the Turkish hearing mothers produced more gesture sentences per hour than did American hearing mothers, and the deaf Turkish homesigners also produced more gesture sentences than did the deaf American homesigners. But this parallel did *not* extend to how the mothers and the children *structured* their gestures. The gestures produced by the hearing mothers of the Turkish homesigners were structured similarly to those produced by the hearing mothers of the American homesigners, although the Turkish mothers used a wider array of forms to package motion events than did the American mothers. More importantly from the point of view of our discussion, both maternal gesture systems were structured differently from their children's gestures. We consider the implications of these findings with respect to the structural properties we have explored: devices for indicating who does what to whom (i.e., production probability and order patterns) and devices for packaging manner and path in the predicate.

### Indicating Who Does What to Whom

*Gesture production and deletion regularities.* The Turkish mothers' gestures did not differ from the American mothers' gestures in terms of how they used production probability to indicate who does what to whom. Everyone, mothers and children alike, distinguished caused-motion actors from patients (they produced more gestures for caused-motion patients than they did for caused-motion actors). But it is the spontaneous-motion actor that is the key to typological distinctions across languages. Here the children were consistent: They produced gestures at the same rate for spontaneous-motion actors and caused-motion patients (thus treating them alike) and at a different rate for caused-motion actors, about which they rarely gestured. In contrast, the mothers displayed no reliable differences in gesture rate between spontaneous-motion actors and caused-motion actors, or between spontaneous-motion actors and caused-motion patients. Thus, the mothers did not display the ergative pattern found in their children's gestures, but they also did not adhere to the nominative pattern found in their spoken languages (in both Turkish and English, spontaneous-motion actors tend to be treated like caused-motion actors, and not like caused-motion patients). There is, of course, no a-priori reason to expect their gestures to follow the nominative pattern, as cospeech gesture need not reflect all aspects of syntactic structure.

These findings suggest that only when gesture is used on its own as a primary communication system (as it is in the deaf children) does it assume a consistent structure characteristic of natural languages. When gesture is used along with speech (as it is in the hearing mothers), it forms an

integrated system with that speech and does not necessarily assume a linguistic structure (in this case, it does not pattern consistently with respect to spontaneous-motion actors, caused-motion actors, and caused-motion patients).

Further support for this hypothesis comes from studies in which hearing adults are asked to use gesture as their primary mode of communication. If we prevent hearing English speakers from talking and ask them to describe a series of vignettes using only their hands, their gestures display the ergative production probability pattern found in the deaf children's homesigns (Goldin-Meadow, Yalabik, & Gershkoff-Stowe, 2000). In other words, the hearing adults do not replicate the pattern found in their spoken language but instead adopt a new pattern, one that has been found in all of the homesign systems described thus far.

But why then are so few languages in the world ergative if the pattern is so basic, and what are the conditions that push a language system away from the ergative pattern? One way to address this question is to observe homesigners who continue to use their gesture systems into adulthood (see Coppola & Newport, 2005) and, in this way, explore the effects that cognitive and social maturity have on the ergative pattern found in child homesign. We can also chart changes that take place with respect to ergative structure when homesigners are brought together into a community and become receivers of their gesture systems as well as producers. Just such a situation has been intensively studied in Nicaragua, where we are able to see the effects on linguistic structure of sharing a language within a community (as well as the effects of transmitting the language to subsequent generations of learners; Goldin-Meadow, 2010; Senghas, 2003).

*Gesture-order regularities.* The Turkish and American deaf children not only all used gesture order to indicate who does what to whom, but they also all displayed the same gesture orders—they tended to produce gestures for caused-motion patients and spontaneous-motion actors before gestures for acts (object-verb [OV], subject-verb [SV]). Deaf children who are exposed to conventional sign languages, not surprisingly, learn the ordering patterns of those languages—for example, subject-object-verb (SVO) in ASL (Chen Pichler, 2008), and SOV in the Sign Language of the Netherlands (Coerts, 2000). It is striking that the homesigners in our studies not only used consistent order in their gesture sentences, but they all used an O-first (or patient-first) order—an order that is consistent with the patient focus found in the children's production probability patterns (i.e., the fact that patients are more likely to be produced than are actors in caused-motion sentences).

The hearing mothers produced very few gesture sentences (often no more than one or two per person), but their gestures did tend to pattern in the same way that their children's gestures did. The small number of gesture sentences that the hearing mothers produced presents a problem for us in terms of conducting statistical analyses. But note that the small numbers may also present a problem for the deaf children. To the extent that the children are using their hearing mothers' gestures as a model, they must be making generalizations from very small amounts of data. In general, our mother data suggest that hearing speakers rarely string their gestures into sentences (see also Goldin-Meadow, McNeill, & Singleton, 1996; McNeill, 1992), but when they do, their gestures follow the ordering patterns found in the deaf children's homesigns.

Not surprisingly, when hearing speakers are asked to abandon speech and use only gesture to communicate, they increase the rate at which they string their gestures together and produce relatively large numbers of gesture sentences (Goldin-Meadow et al., 1996). However, they do *not* pattern these gesture sentences after the sentences that they produce in their spoken

languages. Speakers of Turkish, English, Spanish, and Chinese vary in the word orders they use when they speak, but they all use precisely the same gesture orders when they are asked to describe scenes using only their hands and not their mouths—they produce gestures for actors before gestures for patients in caused motions, and gestures for patients before gestures for acts (Goldin-Meadow, So, Özyürek, & Mylander, 2008). In other words, they display an SOV pattern. This pattern is similar to the homesigners' orders in that O precedes V, and it is also identical to the ordering pattern found in a newly emerging sign language in Israel (Al Sayyid Bedouin Sign Language; Sandler, Meier, Padden, & Aronoff, 2005).

Recent work has replicated the SOV order in hearing speakers of Italian, Turkish, Hebrew, and English asked to gesture without talking (Gibson et al., 2013; Hall, Mayberry, & Ferreira, 2010, 2013; Langus & Nespor, 2010; Meir, Lifshitz, Ilkbasaran, & Padden, 2010). However, these studies have taken the phenomenon one step further and have shown that the hearing gesturers move away from the SOV order under a number of conditions: when asked to describe embedded events (*man tells child that girl catches fish*; Langus & Nespor, 2010), or when asked to describe reversible events (*girl pulls man*; Gibson et al., 2013; Hall et al., 2013; Meir et al., 2010). The interesting question from the point of view of our data is, what are the conditions that push a language system away from the SOV order characteristic of child homesign?

## Packaging Manner and Path in the Verb

Both the Turkish and American homesigners primarily produced *path*-alone gestures when conveying crossing-space events, a finding that is not surprising given that this particular gesture form was the only one found in almost all of the hearing mothers' gestures (the exception was Rana's mother). The fact that *path* is so frequent in the homesigners is also consistent with what hearing children do at the earliest stages of language learning, no matter which spoken language they are learning. For example, 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 English differs from Spanish (which is comparable to Turkish) in how path and manner are expressed (Naigles, Eisenberg, & Kako, 1992). In fact, the preference for manner verbs found in adult English speakers only begins to manifest itself in children by the end of the 3rd year and slowly increases over time (Hohenstein, Naigles, & Eisenberg, 2004). Note, however, that by 4 years of age (the age of our deaf homesigners), English-speaking children are already producing many more manner verbs than are Turkish-speaking children (Ozcaliskan & Slobin, 1999). Thus, 4-year-old American children learning English and Turkish children learning Turkish differ in the rate at which they mention manner, whereas the American and Turkish homesigners we have studied do not. This fact suggests that the heightened reference to manner in English-speaking children relative to Turkish-speaking children is due to the children's *linguistic* environments, and not to some other difference between the cultures, simply because our American and Turkish deaf homesigners experience the same cultural differences as American and Turkish hearing children—they lack access only to linguistic input (see Zheng & Goldin-Meadow, 2002, for evidence that makes a similar point comparing Chinese and American homesigners and hearing children).

All four of the Turkish and two of the American homesigners also produced gesture sentences containing *manner* alone, as did two Turkish and two American mothers. But it was the children, rather than the mothers, who tended to combine manner and path within a sentence. None of the American mothers produced any manner-plus-path combinations at all, and although the Turkish

mothers produced all three types of combinations (*conflated, sequenced, mixed*), each type was produced by only one mother (i.e., no one mother produced all three types).[7] In contrast, the four Turkish children and one American child each produced all three types of manner-plus-path combinations. These children had thus not only combined manner and path into a single gesture (the *conflated* form), but also produced combinations in which manner and path were conveyed in separate gestures, either along with the conflated form (*mixed*) or without it (*sequenced*). As noted in the ''Introduction,'' the ability to segment manner and path into discrete gestures and produce those gestures within a single sentence is found in the first cohort and (in increasing numbers) in subsequent cohorts of Nicaraguan Sign Language (Senghas et al., 2004). The fact that these segmented and sequenced forms are also found in homesign suggests that a communication system need not be shared by a community to display this type of segmenting and sequencing (although the fact that only one American child, compared with four Turkish homesigners, produced the *mixed* and *sequenced* forms suggests that the variety of forms that the Turkish mothers used in their gestures may have encouraged their children to experiment with manner and path gestures).

However, it is important to acknowledge the small sample on which our findings are based, both in terms of number of participants and numbers of gestures. During the two 2-hr observation sessions in which each mother–child dyad was observed, the homesigners, and particularly their mothers, produced relatively few gestures conveying crossing-space events. Thus, our findings must be viewed with caution. Nevertheless, results from experimental work conducted on Turkish homesigners (including the four in our study; see Özyürek, Furman, Kita, & Goldin-Meadow, 2013; Özyürek, Furman, Kita, Sancar, & Goldin-Meadow, 2010) confirms our findings and thus adds weight to those findings. Özyürek et al. (2013) showed vignettes to seven Turkish homesigners (the four in our study and three others) and to Turkish hearing speakers (adults, children, and the deaf children's hearing mothers). The vignettes were designed to highlight manner of motion as an object moves from one location to another (e.g., an object turning on its horizontal axis as it ascended vertically in the air). They found that the Turkish homesigners (but not the Turkish hearing speakers) produced a relatively large number of *mixed* forms in their gestures when describing spontaneous motion in an experimental setting (caused motion was not tested). We found here that all four Turkish homesigners (and one American homesigner) also produced the *mixed* form in a naturalistic conversation.

Interestingly, the *mixed* form has been identified as a predominant form in Nicaraguan Sign Language, but only in the first cohort of signers (i.e., the homesigners who came together for the first time, leading to the birth of the language; Kegl, Senghas, & Coppola, 1999), not in subsequent cohorts of signers or in gesturers in the same community (Senghas, Özyürek, & Goldin-Meadow, 2010, 2013). The *mixed* form thus may be an intermediate stage that bridges the transition from conflated forms that have no segmentation (in hearing gesturers) to sequenced forms that are fully segmented (in deaf signers).

There is one other interesting piece to the manner-plus-path story. When Turkish hearing speakers are asked to describe motion events using their hands and not their mouths, they increase the number of gesture sentences they produce containing both manner and path. But

[7]The Turkish mothers may have been more likely to produce manner-plus-path combinations in their gestures than the American mothers because of the typological properties of spoken Turkish, which packages *path* and *manner* in separate clauses and, in this sense, makes the individual components more salient (Kita & Özyürek, 2003).

almost all of these gesture sentences contain *conflated* forms, not *mixed* or *sequenced* forms (Özyürek et al., 2010, 2013). Thus, when hearing speakers are asked to use gesture as their sole means of communication (i.e., without speech), they use the same production probability (Goldin-Meadow et al., 2000) and ordering patterns (Goldin-Meadow et al., 2008) in their gestures as homesigners do, but they do *not* use the same manner-plus-path patterns (Özyürek et al., 2010, 2013). In other words, hearing speakers' gestures without speech resemble homesign with respect to sentence-level devices indicating who does what to whom, but not with respect to sentence-level expressions of manner and path. This fact lends weight to the possibility that the *mixed* form in particular reflects the children's experimentation with segmentation. Indeed, we see the full range of mixed forms in the homesigners' gestures—they produced manner gestures with the conflated form, as well as path gestures with the conflated form; and they produced the conflated form first followed by either the segmented manner or path form, as well as the segmented form followed by the conflated form. The children seem to be playing with conflation and segmentation, two important properties of natural language.

## CONCLUSION

We found that deaf children who are constructing homesign gesture systems without the benefit of a conventional language model, and in two very different cultures, not only both produced systems that have linguistic structure, but they also created the *same* linguistic structures: They used the same production probability and ordering patterns to indicate who does what to whom as found in previous cross-cultural comparisons (Goldin-Meadow & Mylander, 1998), and they used essentially the same segmentation and conflation patterns to package manner and path. These findings suggest that building sequential structure into the predicates of sentences can also be considered a resilient property of language, one that arises in human language even when the modality easily supports a more simultaneous representational format (cf. Supalla, 1990). Sequencing elements is, of course, a fundamental cognitive skill (Lashley, 1951). But the fact that children who do not have a model for sequencing, as it applies to language, nevertheless apply sequencing to predicates in their communication system suggests that children may come to language learning prepared to seek out sequential structures in their linguistic input, or impose sequential structures on the language systems they create if they have no input.

Importantly, the cospeech gestures that the children's hearing parents produced when talking to them did not display all of the patterns found in the deaf children's homesigns and thus could not have served as a complete model for the children's gesture systems. The hearing mothers in both cultures conveyed the same types of action and static propositions as their children; the mothers' gestures might therefore have served as a model for the content of the children's homesigns. In contrast, the hearing mothers did not use the same structural devices as their children; as a result, the mothers' gestures could not have served as a model for the structural aspects of the children's homesigns. Moreover, the fact that we were able to find similarities between mother and child with respect to content even in our relatively small database suggests that the differences we found with respect to structure do not necessarily stem from the size of our database.

The hearing parents' gestures may have provided the deaf children with an important (perhaps crucial) model for communication per se, and they may have provided building blocks

that the children then used to create their homesign systems. Importantly, however, they did not provide the blueprint for the children's systems, which seems to have come from the children themselves—a possibility supported by the fact that *adults* do not necessarily introduce these patterns into their communications even when asked to use gesture as their sole means of communication (Özyürek et al., 2010, 2013), or when part of a community that is forging a new language (children, rather than adults, appear to have done the creating in Nicaragua; see Senghas, 2003). Our findings thus provide evidence for another aspect of language that is structured the way it is because of children.

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## REFERENCES

Butcher, C., Mylander, C., & Goldin-Meadow, S. (1991). Displaced communication in a self-styled gesture system: Pointing at the non-present. *Cognitive Development*, *6*, 315–342.

Chen Pichler, D. (2008). Acquisition of word order: Then and now. In J. Quer (Ed.), *Selected papers from the 8th Congress on Theoretical Issues in Sign Language Research* (pp. 293–318). Seedorf, Germany: Signum-Verlag.

Coerts, J. A. (2000). Early sign combinations in the acquisition of sign language of the Netherlands: Evidence for language-specific features. In C. Chamberlain, J. P. Morford & R. Mayberry (Eds.), *Language acquisition by eye* (pp. 91–109). Mahwah, NJ: Erlbaum.

Conrad, R. (1979). *The deaf child*. London, England: Harper & Row.

Coppola, M., & Newport, E. (2005). Grammatical subjects in homesign: Abstract linguistic structure in adult primary gesture systems without linguistic input. *Proceedings of the National Academy of Sciences*, *102*, 19249–19253.

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

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, NY: Academic.

Franklin, A., Giannakidou, A., & Goldin-Meadow, S. (2011). Negation, questions, and structure building in a homesign system. *Cognition*, *118*, 398–416.

Furman, R., Özyürek, A., & Allen, S. E. M. (2006). Learning to express causal events across languages: What do speech and gesture patterns reveal?. In D. Bamman, T. Magnitskaia, & C. Zaller (Eds.), *Proceedings of the 30th Annual Boston University Conference on Language Development* (pp. 190–201). Somerville, MA: Cascadilla.

Gibson, E., Pantadosi, S. T., Brink, K., Bergen, L., Lim, E., & Saxe, R. (2013). A noisy-channel account of crosslinguistic word order variation. *Psychological Science*, *24*, 1079–1088.

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, NY: 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* (Vol. 5, pp. 197–245). Hillsdale, NJ: Lawrence Erlbaum & Associates.

Goldin-Meadow, S. (2003). *The resilience of language: What gesture creation in deaf children can tell us about how all children learn language*. New York, NY: Psychology Press.

Goldin-Meadow, S. (2010). Widening the lens on language learning: Language in deaf children and adults in Nicaragua. *Human Development*, *53*, 235–312.

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., Gelman, S., & Mylander, C. (2005). Expressing generic concepts with and without a language model. *Cognition*, *96*, 109–126.

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. (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*, 1–15.

Goldin-Meadow, S., & Mylander, C. (1998). Spontaneous sign systems created by deaf children in two cultures. *Nature*, *91*, 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., Mylander, C., & Franklin, A. (2007). How children make language out of gesture: Morphological structure in gesture systems developed by American and Chinese deaf children. *Cognitive Psychology*, *55*, 87–135.

Goldin-Meadow, S., So, W.-C., Özyürek, A., & Mylander, C. (2008). The natural order of events: How speakers of different languages represent events nonverbally. *Proceedings of the National Academy of Sciences*, *105*, 9163–9168.

Goldin-Meadow, S., Yalabik, E., & Gershkoff-Stowe, L. (2000). The resilience of ergative structure in language created by children and by adults. *Proceedings of the Boston University Conference on Language Development*, *24*, 343–353.

Hall, M., Mayberry, R., & Ferreira, V. (2010). Communication systems shape the natural order of events: Competing biases from grammar and pantomime. In *Abstracts of the 4th Conference of the International Society for Gesture Studies* (p. 182). Amsterdam, The Netherlands: John Benjamins.

Hall, M., Mayberry, R., & Ferreira, V. (2014). *Investigating constituent order change with elicited pantomime: A functional account of SVO emergence*. doi: 10.1111/cogs.12105

Hoffmeister, R., & Wilbur, R. (1980). Developmental: The acquisition of sign language. In H. Lane & F. Grosjean (Eds.), *Recent perspectives on American Sign Language* (pp. 61–78). Hillsdale, NJ: Erlbaum.

Hohenstein, J. M., Naigles, L. R., & Eisenberg, A. R. (2004). Keeping verb acquisition in motion: A comparison of English and Spanish. In G. Hall & S. Waxman (Eds.), *Weaving a lexicon* (pp. 567–602). Cambridge, MA: MIT Press.

Hunsicker, D., & Goldin-Meadow, S. (2012). Hierarchical structure in a self-created communication system: Building nominal constituents in homesign. *Language*, *88*, 732–763.

Kegl, J., Senghas, A., & Coppola, M. (1999). Creation through contact: Sign language emergence and sign language change in Nicaragua. In M. DeGraff (Ed.), *Language creation and language change: Creolization, diachrony, and development* (pp. 179–237). Cambridge, MA: MIT.

Kita, S., & Özyürek, A. (2003). What does cross-linguistic variation in semantic coordination of speech and gesture reveal? Evidence for an interface representation of spatial thinking and speaking. *Journal of Memory and Language*, *48*, 16–32.

Langus, A., & Nespor, M. (2010). Cognitive systems struggling for word order. *Cognitive Psychology*, *60*, 291–318.

Lashley, K. (1951). The problem of serial order in behavior. In L. A. Jeffress (Ed.), *Cerebral mechanisms in behavior* (pp. 112–136). New York, NY: John Wiley.

Lillo-Martin, D. (1999). Modality effects and modularity in language acquisition: The acquisition of American Sign Language. In T. Bhatia & W. Ritchie (Eds.), *Handbook of language acquisition* (pp. 531–567). San Diego, CA: Academic Press.

Mayberry, R. I. (1992). The cognitive development of deaf children: Recent insights. In F. Boller, J. Graffman (Series Eds.), S. Segalowitz, & I. Rapin (Vol. Eds.), *Handbook of neuropsychology: Vol. 7. Child neuropsychology* (pp. 51–68). Amsterdam, The Netherlands: Elsevier.

McNeill, D. (1992). *Hand and mind*. Chicago, IL: University of Chicago Press.

Meadow, K. (1968). Early manual communication in relation to the deaf child's intellectual, social, and communicative functioning. *American Annals of the Deaf*, *113*, 29–41.

Meir, I., Lifshitz, A., Ilkbasaran, D., & Padden, C. (2010). The interaction of animacy and word order in human languages: A study of strategies in a novel communication task. In A. D. M. Smith, M. Schouwstra, B. de Boer, & K. Smith (Eds.), *Proceedings of the Eighth Evolution of Language Conference* (pp. 455–456). Singapore: World Scientific Publishing.

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, August 1992, Antwerp, Belgium.

Newport, E. L., Gleitman, H., & Gleitman, L. R. (1977). Mother, I'd rather do it myself: Some effects and non-effects of maternal speech style. In C. E. Snow & C. A. Ferguson (Eds.), *Talking to children: Language input and acquisition* (pp. 109–149). Cambridge, UK: Cambridge University Press.

Newport, E. L., & Meier, R. P. (1985). The acquisition of American Sign Language. In D. I. Slobin (Ed.), *The cross-linguistic study of language acquisition: Vol. 1. The data*. Hillsdale, NJ: Erlbaum.

Ozcaliskan, S., & Slobin, D. I. (1999). Learning how to search for the frog: Expression of manner of motion in English, Spanish, and Turkish. In A. Greenhill, H. Littlefield, & C. Tano (Eds.), *Proceedings of the 23rd Annual Boston University Conference on Language Development* (pp. 541–552). Boston, MA: Cascadilla.

Özyürek, A., Furman, R., Kita, S., & Goldin-Meadow, S. (in press). *Emergence of segmentation and sequencing in motion event representations without a language model: Evidence from Turkish homesign. Journal of Child Language*, in press.

Özyürek, A., Furman, R., Kita, S., Sancar, B., & Goldin-Meadow, S. (2010). *From gesture to homesign: The emergence of action segmentation and sequencing*. Paper presented at the Conference of the International Society for Gesture Studies, July 2010, Frankfurt (Oder), Germany.

Özyürek, A., & Kita, S. (1999). Expressing manner and path in English and Turkish: Differences in speech, gesture, and conceptualization. *Proceedings of the Cognitive Science Society*, *21*, 507–512.

Özyürek, A., Kita, S., Allen, S., Furman, R., & Brown, A. (2005). How does linguistic framing influence co-speech gestures? Insights from crosslinguistic differences and similarities. *Gesture*, *5*, 216–241.

Papafragou, A., Massey, J., & Gleitman, L. (2006). When English proposes what Greek presupposes: The cross-linguistic encoding of motion events. *Cognition*, *98*(3), B75–B98.

Phillips, S. B. V. D., 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.

Sandler, W., Meier, I., Padden, C., & Aronoff, M. (2005). The emergence of grammar: Systematic structure in a new language. *Proceedings of the National Academy of Sciences*, *102*, 2661–2665.

Senghas, A. (2003). Intergenerational influence and ontogenetic development in the emergence of spatial grammar in Nicaraguan Sign Language. *Cognitive Development*, *18*, 511–531.

Senghas, A., Kita, S., & Özyürek, A. (2004). Children creating core properties of language: Evidence from an emerging Sign Language in Nicaragua. *Science*, *305*, 1779–1782.

Senghas, A., Özyürek, A., & Goldin-Meadow, S. (2010). The evolution of segmentation and sequencing: Evidence from homesign and Nicaraguan Sign Language. In A. D. M. Smith, M. Schouwstra, B. de Boer, & K. Smith, (Eds.), *Proceedings of the Eighth Evolution of Language Conference* (pp. 279–289). Singapore: World Scientific Publishing.

Senghas, A., Özyürek, A., & Goldin-Meadow, S. (2013). Homesign as a way-station between co-speech gesture and sign language: The evolution of segmentation and sequencing. In R. Botha & M. Everaert (Eds.), *Oxford studies in the evolution of language: The evolutionary emergence of human language* (pp. 62–76). London, England: Oxford University Press.

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

Slobin, D. I. (1996). From 'thought and language' to 'thinking to speaking.' In J. J. Gumperz & S. C. Levinson (Eds.), *Rethinking linguistic relativity* (pp. 70–96). Cambridge, UK: Cambridge University Press.

Supalla, T. (1990). Serial verbs of motion in American Sign Language. In S. Fischer (Ed.), *Theoretical issues in sign language research, Volume 1: Linguistics* (pp. 127–152). Chicago, IL: University of Chicago Press.

Zheng, M., & Goldin-Meadow, S. (2002). Thought before language: How deaf and hearing children express motion events across cultures. *Cognition*, *85*, 145–175.