

# Is Seeing Gesture Necessary to Gesture Like a Native Speaker?

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## Abstract

Speakers of all languages gesture, but there are differences in the gestures that they produce. Do speakers learn language-specific gestures by watching others gesture or by learning to speak a particular language? We examined this question by studying the speech and gestures produced by 40 congenitally blind adult native speakers of English and Turkish ( $n = 20/\text{language}$ ), and comparing them with the speech and gestures of 40 sighted adult speakers in each language (20 wearing blindfolds, 20 not wearing blindfolds). We focused on speakers' descriptions of physical motion, which display strong cross-linguistic differences in patterns of speech and gesture use. Congenitally blind speakers of English and Turkish produced speech that resembled the speech produced by sighted speakers of their native language. More important, blind speakers of each language used gestures that resembled the gestures of sighted speakers of that language. Our results suggest that hearing a particular language is sufficient to gesture like a native speaker of that language.

## Keywords

gestures, cross-cultural differences, language development, language

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Speakers of all languages gesture when they talk (Feyereisen & de Lannoy, 1991; Goldin-Meadow, 2003; Kendon, 1980; McNeill, 1992), but there are systematic differences in the gestures that speakers of different languages produce (Gullberg, Hendricks, & Hickmann, 2008; Kita & Özyürek, 2003). Where do these cross-linguistic differences in gesture come from? One possibility is that children learn to gesture in language-specific ways by watching other speakers gesture. An alternative possibility is that children learn language-specific gestures simply by learning to speak a particular language. We turned to congenitally blind speakers to answer this question.

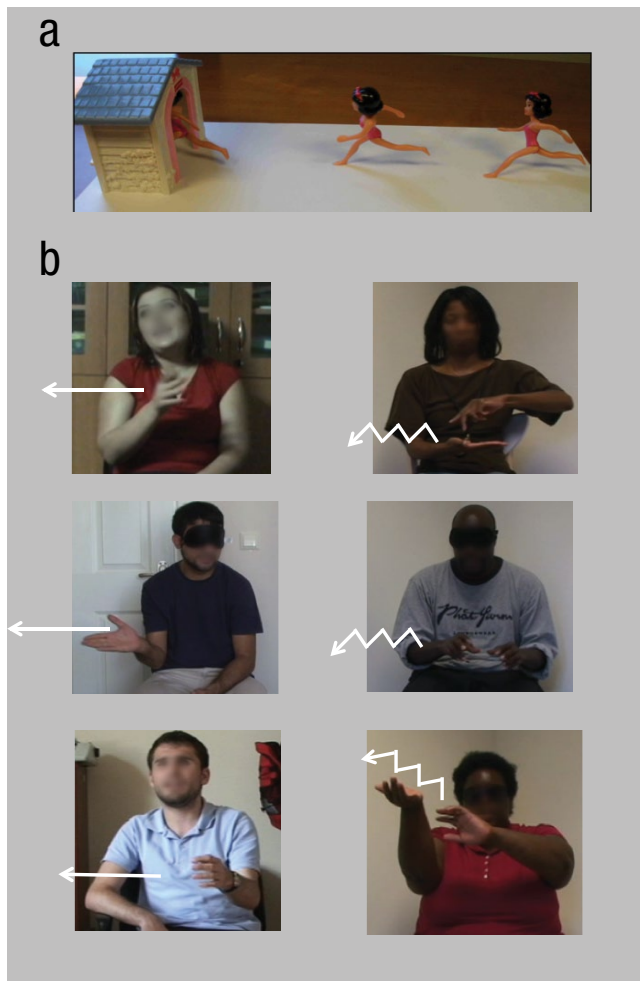
Iverson and Goldin-Meadow (1998) found that congenitally blind English speakers gesture even when talking to other blind individuals, and that the gestures they produce are similar in type and number to the gestures produced by sighted English speakers. However, this study used a reasoning task not known to elicit gesture that varies cross-linguistically. Thus, although it is known that blind speakers gesture, it is not known whether blind speakers of different

languages gesture like sighted speakers of those languages (and thus display language-specific differences in their gestures), or whether all blind speakers gesture in the same generic way. This question can be answered only by studying a domain in which gesture accompanying speech is known to differ across languages, and by studying blind and sighted individuals who could potentially display those differences.

The gestures children see can influence the breadth of their gestural repertoires. Italian children, who live in a gesture-rich world (Kendon, 1995, 2004), use a greater variety of iconic gestures than do American children, whose gestural environments are less varied (Iverson, Capirci, Volterra, & Goldin-Meadow, 2008; see also Furman, Küntay, & Özyürek, 2014). Thus, some aspects of

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**Fig. 1.** Example stimulus scene (a) and its description in gesture (b) by speakers of Turkish (left) and English (right). The still shots and arrows in (b) illustrate the gestures produced by sighted speakers without blindfolds (top row), sighted speakers with blindfolds (middle row), and blind speakers (bottom row). The straight arrows represent separated gestures showing path only (moving across space), and the zigzag arrows represent conflated gestures combining path with manner (running fingers across space).

gesture may be learned from seeing other individuals gesture. If seeing gesture is necessary to gesture like a native speaker, congenitally blind speakers of different languages should all gesture alike, because, according to this hypothesis, they lack the input that would create differences in their gestures. If, on the other hand, individuals become native gesturers by becoming native speakers, congenitally blind speakers of a given language should produce gestures similar to the gestures produced by sighted speakers of the same language.<sup>1</sup>

We tested these hypotheses by studying the gestures speakers produce when describing events in a domain

characterized by strong cross-linguistic variability: motion across space (Talmy, 2000). Speakers of Turkish and English produce distinctively different gestures when describing manner (e.g., *running*) and path (e.g., *entering*) components of motion (Kita & Özyürek, 2003; Özçalışkan, 2015a). English speakers typically conflate manner and path components into a single gesture, whereas Turkish speakers produce separate gestures for manner and path and tend to produce more path-only than manner-only gestures (cf. the Turkish and English speakers in the top row of Fig. 1b); these gesture patterns mirror patterns found in spoken English and Turkish (Choi & Bowerman, 1991; Özçalışkan & Slobin, 1999; Slobin, 1996). Although these cross-linguistic patterns in gesture are robust, little is known about their source. We turned to gestures produced by individuals who have been blind from birth and who speak different languages to explore the etiology of this variation.

## Method

### Participants

Participants included 40 congenitally blind adults (20 native English speakers and 20 native Turkish speakers). We compared these blind speakers with 80 sighted adult speakers, 40 in each language (20 who wore blindfolds, 20 who did not wear blindfolds), as they described scenes involving physical motion (e.g., a girl running into a house, as in Fig. 1a).<sup>2</sup> The selection criteria for the blind speakers were that they have an ophthalmologic diagnosis of congenital blindness, with light perception at best, and no other documented physical, neurological, or mental deficits.<sup>3</sup> We had half of the sighted adults in each language perform the task with their vision unimpeded and half perform the task while wearing a blindfold to make sure that preventing sighted individuals from seeing the stimuli would not affect their patterns of speech or gesture. Within each language group, the sighted adults with and without blindfolds were comparable to the blind adults with respect to age; there were more females than males in each of the English-speaking groups, but not in the Turkish-speaking groups (see Table 1).

### Procedure

Participants were videotaped while describing 12 three-dimensional scenes displaying motion along three different types of paths—4 paths *to* a landmark (e.g., running into a house), 4 paths *over* a landmark (e.g., flipping over a beam), and 4 paths *from* a landmark (e.g., running away from a motorcycle). The scenes displayed various manners of motion (e.g., running, flipping, crawling). For

**Table 1.** Characteristics of the Sample

Characteristic	English speakers			Turkish speakers		
	Blind	Sighted with blindfold	Sighted without blindfold	Blind	Sighted with blindfold	Sighted without blindfold
Mean age	44 (15)	40 (12)	43 (13)	30 (9)	26 (6)	26 (7)
Age range	22–71	22–60	23–71	20–50	20–42	20–46
Gender (male/ female)	6/14	8/12	5/15	14/6	10/10	10/10

Note: Each group included 20 participants. Standard deviations are given in parentheses.

each type of path, 3 scenes depicted movement across a spatial boundary (movement into, over, or out of a landmark), and 1 depicted movement that did not cross a boundary (movement toward, along, or away from a landmark). Table 2 lists the manners and paths used in the 12 scenes.

Each scene was preconstructed on a 5- × 15-in. white foam board and contained a landmark and three identical stationary dolls (named Eve in English and Oya in Turkish) in varying postures intended to capture three snapshots of a continuous motion with manner and path (see Fig. 1a). The landmark and dolls were glued to the foam board so that presentation of the materials would be uniform across groups. The blind individuals and sighted individuals who wore blindfolds explored the stimuli haptically with their hands, without any visual exposure; the sighted individuals who did not wear blindfolds explored the stimuli visually, without any haptic exposure. Participants were told that Eve/Oya appeared three

times in each scene, but that they should think of her movement as a single continuous motion and describe it as such.

In pilot work, we found lower rates of spontaneous gesturing in blind speakers than in sighted speakers. To maximize the chances that equal numbers of blind and sighted participants would gesture, we told participants to use their hands as naturally as possible as they described each scene. In a few cases, participants did not gesture when describing a scene; we then asked them to describe the scene again, but using their hands.<sup>4</sup> To familiarize participants with the task, we asked them to complete two practice trials before the test scenes. Presentation order of the test scenes was counterbalanced across participants within each group. Counterbalancing was done in three blocks, each containing four items, one of each of the three different path types with boundary crossing (into, out of, or over) and one non-boundary-crossing event.

**Table 2.** List of Motion Events Used in the Study

Description	Path in relation to landmark	Manner
Motion to a landmark		
Running into a house	Into a landmark	Running
Crawling into a house	Into a landmark	Crawling
Climbing into a tree house	Into a landmark	Climbing
Walking toward a crib	Toward a landmark	Walking
Motion over a landmark		
Crawling over a carpet	Over a landmark	Crawling
Jumping over a hurdle	Over a landmark	Jumping
Flipping over a beam	Over a landmark	Flipping
Crawling along tracks	Along a landmark	Crawling
Motion from a landmark		
Running out of a house	Out of a landmark	Running
Rolling out of a tunnel	Out of a landmark	Rolling
Crawling out of a house	Out of a landmark	Crawling
Running away from a motorcycle	Away from a landmark	Running

## Coding

Speech was transcribed and segmented into spoken sentence units. The minimum sentence unit in speech contained one verb and associated arguments (e.g., *Eve runs into the house*; *Oya eve koşuyor*, “Oya house-to runs”); some sentence units in speech contained a subordinate clause as well (e.g., *Eve enters the house running*; *Oya eve girer koşarak*, “Oya house-into enter running”). We also transcribed all gestures that accompanied each spoken sentence unit. Gesture was defined as communicative hand movement that had an identifiable beginning and end; in our analysis, we included only gestures that conveyed characteristic actions or features associated with the stimulus scenes. A spoken sentence unit could be accompanied by one or more gestures (e.g., a manner gesture alone or a manner gesture followed by a path gesture); we treated all gestures that accompanied a given spoken sentence unit as a gesture sentence unit.

Sentence units in speech and gesture were further coded for packaging of different types of motion elements: A sentence unit in speech was coded as *conflated* if it conveyed both manner and path within a single spoken clause (e.g., *Eve runs into the house*; *Oya eve koşuyor*, “Oya house-to runs”); it was coded as *separated* if it conveyed only manner (e.g., *she is running*; *koşuyor*, “running”), only path (e.g., *she enters the house*; *eve girer*, “house-to enters”), or manner and path in two separate clauses, with path in the verb of the main clause and manner in a subordinate clause (*Eve enters the house running*; *Oya giriyor eve koşarak*, “Oya house-to enters running”). This construction appeared only six times in English, but was frequent in Turkish. Turkish speakers occasionally used a third strategy in speech, combining a neutral verb that does not convey path (e.g., *go*, “move”) with path in a satellite and manner in a subordinate second clause (e.g., *Oya koşarak eve gitti*, “Oya went to the house running”). These instances were classified as *separated* (i.e., manner and path in two clauses). Agreement between coders was 100% for coding motion elements in speech.

Sentence units in gesture were also coded for packaging of different types of motion elements. A sentence unit in gesture was coded as *conflated* if it conveyed manner and path simultaneously within a single gesture (e.g., fingers wiggled as the hand moved across space, as illustrated on the right in Fig. 1b); it was coded as *separated* if it conveyed manner only (e.g., fingers wiggled in place in an upside-down V) or path only (e.g., hand moved across space, as illustrated on the left in Fig. 1b). A sentence unit in gesture that consisted of a gesture conveying manner followed by a gesture conveying path (e.g., fingers wiggled in place and then a finger moved across space), or

vice versa, was also coded as *separated*. Participants in all groups also produced conflated gestures followed by separated gestures within a single sentence unit. Mixed responses of this sort accounted for approximately 4% of the data in each group and were excluded from the analyses. Agreement between coders was 93% for identifying gestures; 96% for describing gesture form (i.e., iconic, deictic, or beat); and 90% for coding motion elements in gesture.

## Analysis

Using R (R Core Team, 2013) and the *glmer()* function in the *lme4* library (Bates, Maechler, Bolker, & Walker, 2014), we analyzed the count data by fitting generalized linear mixed-effects models with a Poisson distribution function. Language (English, Turkish) and group (blind, sighted without blindfold, sighted with blindfold) were between-subjects and within-items factors, respectively. Packaging (*separated*, *conflated*) and output channel (speech, gesture) were within-subjects and within-items factors, respectively. Path type (*to*, *over*, *from*) was a within-subjects and between-items factor. All factors were treatment coded (see Table 3 for a list of all factors used in the analyses and the reference level for each factor). We treated subject ( $N = 120$ ) and scene ( $N = 12$ ) as random effects, including random intercepts for both in all analyses.<sup>5</sup> To control for effects of type of path, we included path type as a fixed effect in all models. Our procedure was the same for all statistical tests. If a statistical test involved a subset of the data, we first excluded all irrelevant data. For example, to test for a difference between blind English and Turkish speakers in frequency of conflated gesture packaging, we selected only the data for the relevant levels of the factors: language (English, Turkish), group (blind), packaging (conflated), and output channel (gesture). We then fit a model that included the term we wanted to test (in this case, language). Next, we fit a reduced model that excluded the term we wanted to test but was otherwise the same. Finally, we compared the models using a likelihood ratio test via the *anova()* command. This procedure compared the relative fits (expressed as log likelihoods) of the two models to test

**Table 3.** Factors Used in the Analyses

Factor	Reference level
Language	English
Group	Blind
Packaging	Conflated
Path type	<i>To</i>
Scene	One
Subject	One



the statistical significance of the term removed in the reduced model (in this case, language). We report the chi-square statistics, degrees of freedom, and  $p$  values for these tests.

## Predictions

If speakers learn language-specific gestures by watching others gesture, then blind speakers of English should not display the gesture patterns unique to sighted English speakers, nor should blind speakers of Turkish display the gesture patterns unique to sighted Turkish speakers. We would thus expect sighted speakers, but not blind speakers, to display language-specific gesture patterns, and we would expect an interaction of group, language, and packaging. The fact that children growing up in gesture-rich environments such as Italy or Turkey have larger gestural repertoires than children growing up in less gesture-rich environments (Furman et al., 2014; Iverson et al., 2008) suggests that the gestures individuals see others produce can have an impact on their own gestures, lending weight to this first hypothesis.

In contrast, if speakers learn language-specific gestures by learning to speak their language, then blind speakers of English should gesture like sighted speakers of English, and blind speakers of Turkish should gesture like sighted speakers of Turkish. In this case, we would expect differences between English and Turkish speakers (i.e., a significant interaction between language and packaging), but no differences between blind and sighted speakers within each language (i.e., no effect of group). The fact that gesture and speech form a single integrated system under most circumstances (Goldin-Meadow, 2003; McNeill, 1992; but see note 1) suggests that gesture should go hand in hand with speech, and that speakers (blind or sighted) of the same language should gesture alike, and differently from speakers (blind or sighted) of a different language.

## Results

The tables in the appendix present the mean number of separated and conflated motion elements produced in speech and gesture for each scene by speakers of each language in each group. Here, we summarize the results of our regression analyses. (The details on the regression models and outputs are provided in the Supplemental Material available online.)

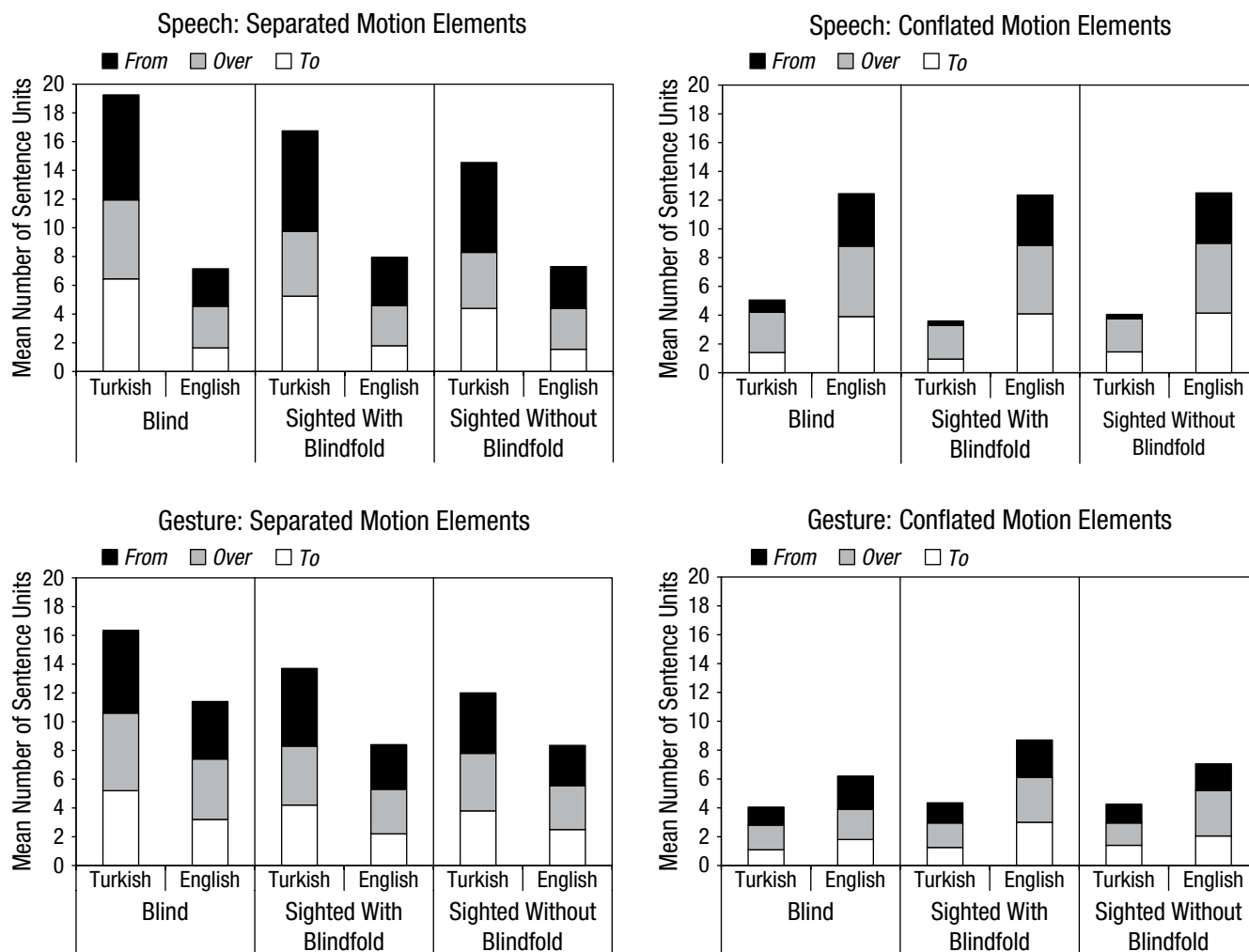
### *Packaging motion elements in speech*

Both sighted and blind speakers showed the expected cross-linguistic differences in speech (Fig. 2, top panels).

We found a Language  $\times$  Packaging interaction in speech for each group—sighted without blindfold (Model 1):  $b = 2.20$ ,  $\chi^2(1) = 19.49$ ,  $p < .001$ ; sighted with blindfold (Model 2):  $b = 2.34$ ,  $\chi^2(1) = 24.82$ ,  $p < .001$ ; blind (Model 3):  $b = 2.12$ ,  $\chi^2(1) = 22.74$ ,  $p < .001$ . We then tested for a three-way Language  $\times$  Packaging  $\times$  Group interaction to see if the two-way interaction varied by group, and found that it did not (Model 4)—sighted with blindfold relative to blind:  $b = 0.09$ ; sighted without blindfold relative to blind:  $b = -0.08$ ,  $\chi^2(2) = 0.48$ ,  $p = .785$ .<sup>6</sup> English and Turkish speakers thus differed in their packaging of motion elements in speech whether they were sighted or blind and, if sighted, whether or not they wore a blindfold.

We explored these interactions by contrasting packaging of motion elements in speech between the two languages within each group (see Table 4 for a detailed summary of the frequency of the various types of sentence units in speech, including a breakdown of types of responses within the separated category). As expected, within every group, Turkish speakers produced more separated sentence units in speech than English speakers did—sighted without blindfold (Model 5):  $b = 1.01$ ,  $\chi^2(1) = 14.95$ ,  $p < .001$ ; sighted with blindfold (Model 6):  $b = 0.91$ ,  $\chi^2(1) = 16.71$ ,  $p < .001$ ; blind (Model 7):  $b = 1.13$ ,  $\chi^2(1) = 23.39$ ,  $p < .001$ . In contrast, and again as expected, English speakers in each group produced more conflated sentence units than Turkish speakers in the same group—sighted without blindfold (Model 8):  $b = -1.42$ ,  $\chi^2(1) = 18.12$ ,  $p < .001$ ; sighted with blindfold (Model 9):  $b = -1.57$ ,  $\chi^2(1) = 19.69$ ,  $p < .001$ ; blind (Model 10):  $b = -1.07$ ,  $\chi^2(1) = 17.42$ ,  $p < .001$ .

To determine whether these cross-linguistic differences varied by path type, we tested whether there was a significant Language  $\times$  Packaging  $\times$  Path Type interaction for each group. This higher-order interaction was significant for all three groups—sighted without blindfold (Model 11):  $b = -1.03$  for *over* relative to *to* paths,  $b = 1.13$  for *from* relative to *to* paths,  $\chi^2(2) = 22.42$ ,  $p < .001$ ; sighted with blindfold (Model 12):  $b = -1.35$  for *over* relative to *to* paths,  $b = 0.66$  for *from* relative to *to* paths,  $\chi^2(2) = 22.55$ ,  $p < .001$ ; blind (Model 13):  $b = -1.19$  for *over* relative to *to* paths,  $b = 0.10$  for *from* relative to *to* paths,  $\chi^2(2) = 15.32$ ,  $p < .001$ . Thus, the cross-linguistic effect did vary by path type. However, the two-way Language  $\times$  Packaging interaction was also significant at every level of path type and at every level of group (Models 14–22:  $p < .05$  for all nine tests); that is, for each of the three path types produced by each of the three groups, Turkish speakers produced more separated sentence units than English speakers, and English speakers produced more conflated sentence units than Turkish speakers (Fig. 2, top panels).



**Fig. 2.** Mean number of sentence units with separated and conflated packaging of motion elements. The top row presents results for speech, and the bottom row presents results for gesture. Means across all three path types are shown separately for Turkish and English speakers in each of the three groups, and means for each of the three path types (*to*, *over*, and *from*) are indicated by the shading.

### Packaging motion elements in gesture

On the basis of previous studies (Gullberg et al., 2008; Kita & Özyürek, 2003), we expected the cross-linguistic patterns found in speech to also appear in gesture in sighted participants. Our question was whether these patterns would appear in blind participants as well. We found that they did. Figure 2 (bottom panels) presents the data. As in the speech analyses, we found a Language  $\times$  Packaging interaction in gesture for each group—sighted without blindfold (Model 23):  $b = 0.85$ ,  $\chi^2(1) = 16.62$ ,  $p < .001$ ; sighted with blindfold (Model 24):  $b = 1.26$ ,  $\chi^2(1) = 18.44$ ,  $p < .001$ ; blind (Model 25):  $b = 0.80$ ,  $\chi^2(1) = 16.64$ ,  $p < .001$ . We then tested for a three-way Language  $\times$  Packaging  $\times$  Group interaction to see if the two-way interaction varied by group, and found that it did not (Model 26)—sighted

with blindfold relative to blind:  $b = 0.40$ ; sighted without blindfold relative to blind:  $b = 0.08$ ;  $\chi^2(2) = 3.22$ ,  $p = .200$ . English and Turkish speakers thus differed in their packaging of motion elements in gesture whether they were sighted or blind and, if sighted, whether or not they wore a blindfold.

We explored these interactions by contrasting packaging of motion elements in gesture between the two languages within each group (see Table 4 for a detailed summary of the frequency of the various types of gestures, including a breakdown of types of responses within the separated category). As in their speech, Turkish speakers in each group produced more separated gestures than English speakers in the same group—sighted without blindfold (Model 27):  $b = 0.48$ ,  $\chi^2(1) = 6.93$ ,  $p = .008$ ; sighted with blindfold (Model 28):  $b = 0.49$ ,  $\chi^2(1) = 6.72$ ,

**Table 4.** Mean Number of Separated and Conflated Sentence Units Produced in Speech and in Gesture by Each Group

Modality and group	Separated						Conflated	
	Path only		Manner only		Path and manner in two clauses or two sequential gestures		Path and manner in one clause or one gesture	
	Turkish	English	Turkish	English	Turkish	English	Turkish	English
<b>Speech</b>								
Blind	12.90 (5.12)	5.30 (3.80)	3.05 (3.28)	1.80 (1.67)	2.85 (3.27)	0.20 (0.62)	5.45 (2.86)	13.0 (4.35)
Sighted with blindfold	11.15 (4.51)	5.80 (3.87)	2.05 (3.09)	2.30 (2.81)	3.30 (3.67)	0.05 (0.22)	3.50 (1.82)	13.10 (3.63)
Sighted without blindfold	5.25 (2.88)	4.55 (4.48)	2.75 (2.59)	2.70 (2.66)	6.55 (2.80)	0.05 (0.22)	4.05 (2.44)	12.60 (3.76)
<b>Gesture</b>								
Blind	15.35 (6.18)	7.10 (6.70)	0.80 (1.94)	4.10 (13.50)	0.20 (0.52)	0.45 (1.36)	4.05 (5.27)	6.15 (4.90)
Sighted with blindfold	10.70 (5.34)	6.50 (5.54)	2.10 (4.72)	1.80 (3.12)	0.75 (1.41)	0.10 (0.31)	4.40 (4.54)	8.70 (5.08)
Sighted without blindfold	9.45 (5.93)	6.35 (5.82)	1.55 (2.35)	1.80 (2.63)	1.00 (1.95)	0.25 (0.55)	4.25 (4.61)	7.05 (4.54)

Note: Standard deviations are given in parentheses.

$p = .010$ ; blind (Model 29):  $b = 0.75$ ,  $\chi^2(1) = 7.74$ ,  $p = .005$ . In contrast, in every group, English speakers produced more conflated gestures than Turkish speakers did—sighted without blindfold (Model 30):  $b = -0.78$ ,  $\chi^2(1) = 5.73$ ,  $p = .016$ ; sighted with blindfold (Model 31):  $b = -0.96$ ,  $\chi^2(1) = 11.80$ ,  $p < .001$ ; blind (Model 32):  $b = -0.97$ ,  $\chi^2(1) = 5.23$ ,  $p = .022$ .

To determine whether these cross-linguistic differences in gesture varied by path type, we tested whether there was a significant Language  $\times$  Packaging  $\times$  Path Type interaction for each group. We found no evidence of a three-way interaction in any of the three groups—sighted without blindfold (Model 33):  $b = 0.18$  for *over* relative to *to* paths,  $b = -0.04$  for *from* relative to *to* paths,  $\chi^2(2) = 0.34$ ,  $p = .846$ ; sighted with blindfold (Model 34):  $b = -0.64$  for *over* relative to *to* paths,  $b = -0.35$  for *from* relative to *to* paths,  $\chi^2(2) = 2.51$ ,  $p = .285$ ; blind (Model 35):  $b = -0.52$  for *over* relative to *to* paths,  $b = -0.01$  for *from* relative to *to* paths,  $\chi^2(2) = 2.20$ ,  $p = .334$ . That is, for each of the three path types produced by each of the three groups, Turkish speakers produced more separated gestures than English speakers, and English speakers produced more conflated gestures than Turkish speakers (Fig. 2, bottom panels), just as they did in speech. Blind individuals show the same cross-linguistic differences in gesture that sighted individuals do, despite not being able to observe others gesturing.

### Discussion

This study replicates previous work showing that sighted speakers of Turkish package manner and path gestures

differently from sighted speakers of English (Gullberg et al., 2008; Kita & Özyürek, 2003). But we took this work one important step further by showing that blind speakers of these two languages package manner and path gestures in precisely the same ways as sighted speakers of these languages. Our findings thus underscore the tight link between speech and gesture, and identify speech as the source of the cross-linguistic variation observed in gesture. Blind speakers learn language-specific gestures by learning to speak the language, not by watching others move.

However, gesture and speech can be out of sync at various points in development. For example, children learning Turkish and those learning English display language-specific speech by age 3 (separated packaging in Turkish, conflated packaging in English) but use the same gestures until age 9 (separated packaging; Özyürek et al., 2008). Between the ages of 3 and 9, English learners thus produce separated gesture along with conflated speech, which suggests that language-specific gesture takes time to develop. Does seeing the gestures that other individuals produce influence when language-specific gestures first emerge? If so, blind children’s gestures and sighted children’s gestures ought to follow different developmental trajectories. Studies of congenitally blind children at different points in language learning will show whether the onset of language-specific patterns in gesture is affected by seeing other people gesture. Whatever the developmental trajectories, our findings make it clear that the final state does not depend on seeing gesture—language-specific gesture can be learned just by learning the language.

## Appendix

**Table A1.** Mean Number of Separated and Conflated Sentence Units in Speech for Each Scene

Path type and scene	Separated packaging						Conflated packaging						
	Blind participants		Sighted participants with blindfold		Sighted participants without blindfold		Blind participants		Sighted participants with blindfold		Sighted participants without blindfold		
	T	E	T	E	T	E	T	E	T	E	T	E	
Motion to a landmark													
Running into a house	2.25	0.75	1.30	0.60	1.45	0.30	0.20	0.70	0.10	0.90	0.20	1.05	1.05
Crawling into a house	1.60	0.25	1.40	0.50	1.25	0.65	0.20	1.05	0.15	0.95	0.20	1.00	1.00
Climbing into a tree house	1.40	0.35	1.10	0.45	0.85	0.25	0.45	1.15	0.50	1.30	0.70	1.20	1.20
Walking toward a crib	1.20	0.30	1.45	0.25	0.85	0.35	0.55	1.00	0.20	0.95	0.35	0.90	0.90
Mean for <i>to</i> paths	6.45	1.65	5.25	1.80	4.40	1.55	1.40	3.90	0.95	4.10	1.45	4.15	4.15
Motion over a landmark													
Crawling over a carpet	1.70	0.45	1.25	0.60	1.30	0.60	0.30	1.35	0.35	1.20	0.25	1.45	1.45
Jumping over a hurdle	1.40	0.60	0.90	0.80	0.90	0.90	1.05	1.40	1.10	1.40	1.00	1.40	1.40
Flipping over a beam	1.85	1.50	1.30	1.15	0.95	1.10	0.70	1.10	0.50	1.20	0.65	1.05	1.05
Crawling along tracks	0.55	0.35	1.05	0.25	0.75	0.25	0.75	1.05	0.40	0.95	0.40	0.95	0.95
Mean for <i>over</i> paths	5.50	2.90	4.50	2.80	3.90	2.85	2.80	4.90	2.35	4.75	2.30	4.85	4.85
Motion from a landmark													
Running out of a house	1.80	0.85	1.55	0.90	1.90	1.10	0.45	0.90	0.05	0.65	0.05	0.55	0.55
Rolling out of a tunnel	2.10	0.70	1.85	1.10	1.45	0.70	0.10	0.90	0.10	0.90	0.10	1.10	1.10
Crawling out of a house	1.75	0.40	1.70	0.60	1.35	0.55	0.15	0.90	0.10	0.90	0.05	0.90	0.90
Running away from a motorcycle	1.65	0.65	1.90	0.75	1.55	0.55	0.15	0.95	0.05	1.05	0.10	0.95	0.95
Mean for <i>from</i> paths	7.30	2.60	7.00	3.35	6.25	2.90	0.85	3.65	0.30	3.50	0.30	3.50	3.50

Note: T = Turkish speakers; E = English speakers.



**Table A2.** Mean Number of Separated and Conflated Sentence Units in Gesture for Each Scene

Path type and scene	Separated packaging						Conflated packaging					
	Blind participants		Sighted participants with blindfold		Sighted participants without blindfold		Blind participants		Sighted participants with blindfold		Sighted participants without blindfold	
	T	E	T	E	T	E	T	E	T	E	T	E
Motion to a landmark												
Running into a house	1.25	0.70	0.90	0.60	1.45	0.85	0.45	0.40	0.35	0.85	0.15	0.30
Crawling into a house	1.50	0.85	1.30	0.40	0.75	0.50	0.30	0.55	0.15	0.75	0.45	0.90
Climbing into a tree house	1.30	1.00	0.85	0.65	0.85	0.65	0.20	0.40	0.55	0.85	0.40	0.55
Walking toward a crib	1.15	0.65	1.15	0.55	0.75	0.50	0.15	0.45	0.20	0.55	0.40	0.30
Mean for <i>to</i> paths	5.20	3.20	4.20	2.20	3.80	2.50	1.10	1.80	1.25	3.00	1.40	2.05
Motion over a landmark												
Crawling over a carpet	1.30	1.00	1.00	0.70	1.15	0.60	0.60	0.50	0.40	0.75	0.45	0.75
Jumping over a hurdle	1.45	1.00	1.35	0.85	1.10	1.05	0.40	0.60	0.40	0.90	0.30	0.95
Flipping over a beam	1.55	1.35	0.65	0.95	1.00	0.80	0.45	0.55	0.80	1.10	0.60	0.80
Crawling along tracks	1.10	0.85	1.10	0.60	0.75	0.60	0.25	0.45	0.10	0.35	0.20	0.65
Mean for <i>over</i> paths	5.40	4.20	4.10	3.10	4.00	3.05	1.70	2.10	1.70	3.10	1.55	3.15
Motion from a landmark												
Running out of a house	1.55	0.85	1.20	0.75	1.10	0.75	0.30	0.60	0.25	0.40	0.35	0.25
Rolling out of a tunnel	1.50	0.70	1.40	1.05	1.00	0.85	0.50	0.75	0.65	0.90	0.40	0.65
Crawling out of a house	1.25	1.05	1.10	0.45	0.95	0.55	0.30	0.50	0.25	0.80	0.30	0.45
Running away from a motorcycle	1.45	1.40	1.70	0.85	1.15	0.65	0.15	0.45	0.25	0.50	0.25	0.50
Mean for <i>from</i> paths	5.75	4.00	5.40	3.10	4.20	2.80	1.25	2.30	1.40	2.60	1.30	1.85

Note: T = Turkish speakers; E = English speakers.

## Action Editor

Matthew A. Goldrick served as action editor for this article.

## Author Contributions

Ş. Özçalışkan and S. Goldin-Meadow contributed to the study concept and design. Ş. Özçalışkan developed the stimuli and collected and coded the data. C. Lucero conducted the data analysis in collaboration with Ş. Özçalışkan and S. Goldin-Meadow. Ş. Özçalışkan and S. Goldin-Meadow drafted the manuscript, and all three authors provided critical revisions and approved the final version of the manuscript for submission.

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The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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## Supplemental Material

Additional supporting information can be found at <http://pss.sagepub.com/content/by/supplemental-data>

## Open Practices

We have not received permission from our participants to share their video data publicly; therefore, to respect their confidentiality, we cannot make these data available. The complete Open Practices Disclosure for this article can be found at <http://pss.sagepub.com/content/by/supplemental-data>.

## Notes

1. Although many researchers theorize that gesture and speech form an integrated system (e.g., McNeill, 1992), gesture and speech can be decoupled. For example, when native Turkish speakers who are advanced learners of English speak English, they speak like monolingual English speakers but gesture like monolingual Turkish speakers (Özçalışkan, 2015a). Also, children learning Turkish and those learning English display language-specific speech by age 3, but use the same gestures until age 9 (both use the Turkish pattern); between ages 3 and 9, English learners thus use gestures that are out of sync with their speech (Özyürek et al., 2008). Gesture is thus not inevitably tied to speech, which leaves

open the possibility that blind speakers' gestures will not parallel their speech.

2. Power calculations for selecting the sample size were based on a previous cross-linguistic study (Özçalışkan, 2015b), which obtained an effect size,  $\eta^2$ , of .21, with 20 participants per group. Our calculations indicated that an experiment with a sample of this size would provide a minimum of 94% power to detect an effect of this magnitude when a  $p$  level of .05 was used.

3. Two American and 3 Turkish blind participants lost their vision between ages 1 and 3; the remaining 35 either were born blind ( $n = 32$ ) or became blind within the first few months following birth ( $n = 3$ ).

4. To determine whether telling speakers to gesture affected not only their gesture rate but also their gesture patterns, we studied an additional 58 adult participants (28 English speakers, 30 Turkish speakers), who performed the same task but without instructions to gesture. Most sighted participants (17 of 20 English speakers, 19 of 20 Turkish speakers), but fewer blind participants (2 of 8 English speakers, 7 of 10 Turkish speakers), gestured. However, the participants who did gesture displayed the same patterns as those reported here for participants instructed to gesture. The Turkish speakers produced more separated gestures than the English speakers (blind: 97% vs. 25%; sighted without blindfold: 91% vs. 64%; sighted with blindfold: 85% vs. 66%), and the English speakers produced more conflated gestures than the Turkish speakers (blind: 75% vs. 3%; sighted without blindfold: 36% vs. 9%; sighted with blindfold: 34% vs. 15%).

5. We used the *maximal* approach (Barr, Levy, Scheepers, & Tily, 2013) and included random slopes for subject and for scene when the data were able to support the complexity of these slope estimations (Barr, 2013). When a model did not converge, we increased the maximum iterations to 30,000. If it still did not converge, we degraded the model by removing correlation parameters between random slopes and intercepts (although in practice, this procedure never caused a recalcitrant model to converge). Next, we removed random slopes for either subject or scene. The last step was to use a random-intercepts-only model (see the Supplemental Material). When a model converged only with random slopes for subject or for scene, we report the more conservative result.

6. All three-way interactions included either group or path type, both of which were three-level factors. Thus, there were 2 degrees of freedom in all of the three-way tests we report.

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