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Blind Speakers Show Language-Specific Patterns in Co-Speech Gesture but *Not* Silent Gesture

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Abstract

Sighted speakers of different languages vary systematically in how they package and order components of a motion event in speech. These differences influence how semantic elements are organized in gesture, but only when those gestures are produced with speech (co-speech gesture), not without speech (silent gesture). We ask whether the cross-linguistic similarity in silent gesture is driven by the visuospatial structure of the event. We compared 40 congenitally blind adult native speakers of English or Turkish (20/language) to 80 sighted adult speakers (40/language; half with, half without blindfolds) as they described three-dimensional motion scenes. We found an effect of language on co-speech gesture, not on silent gesture—blind speakers of both languages organized their silent gestures as sighted speakers do. Humans may have a natural semantic organization that they impose on events when conveying them in gesture without language—an organization that relies on neither visuospatial cues nor language structure.

Keywords: Gesture; Blindness; Cross-linguistic differences; Language and cognition; Co-speech gesture; Silent gesture; Motion events; Spatial language and gesture

1. Introduction

Adult sighted speakers show systematic cross-linguistic differences in the way they package and order semantic components of an event in their speech (Talmy, 2000). Slobin (1996) has suggested that these language-specific patterns influence nonverbal representation of events, but only during online production of speech (i.e., thinking for speaking). Previous work exploring the influence of language-specific patterns on nonverbal representation of events as expressed in gesture has provided evidence for this

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hypothesis (Özçalışkan, Lucero, & Goldin-Meadow, 2016a): Language-specific patterns appear in the gestures that sighted adult speakers produce along with their talk (i.e., co-speech gesture), suggesting an online effect of language on nonverbal representations of events in gesture. Importantly, however, these patterns do *not* appear in the gestures that sighted adults produce when asked to gesture without speech (i.e., silent gesture). Instead, English and Turkish speakers display the *same* patterns in their silent gestures, suggesting that language does *not* have an offline effect on nonverbal representation of events as viewed through gesture (at least in this domain).

What explains the cross-linguistic universality in silent gesture? One possibility is that the patterns in silent gesture are driven by visuospatial cues afforded by the event itself. If so, we would predict that blind speakers—who lack such cues—might eschew these universal patterns and follow the language-specific patterns found in their co-speech gestures (Özçalışkan, Lucero, & Goldin-Meadow, 2016b) when also organizing their silent gestures. Alternatively, if representation of events in silent gesture reflects a natural semantic organization—independent of language and vision—we would predict that blind speakers would show the same patterns as sighted speakers in packaging and ordering motion elements in their silent gestures.

We test these possibilities by studying the co-speech and silent gestures produced by congenitally blind and sighted speakers of two structurally different languages (English vs. Turkish) when describing motion events. Descriptions of motion in space differ systematically in English versus Turkish. As proposed by Talmy (2000), a motion event consists of several components, including a moving *figure*, a *landmark* in relation to which the figure moves, a *path* that relates the figure's motion to the landmark, and a *manner* that conveys the way the figure moves. The *packaging* of manner and path components shows systematic variability across the world's languages, offering a binary split between satellite-framed languages (like English) and verb-framed languages (like Turkish) (Talmy, 1985, 2000). English speakers use a *conflated* strategy when talking about motion across space, expressing manner in the verb and path in a satellite (preposition, particle) associated with the verb, all within a single clausal segment; for example, "girl RUNS [manner] out of the house [path]." In contrast, Turkish speakers use a *separated* strategy in speech, expressing path in the verb in one clause, and manner outside the verb in a separate subordinate clause; for example, "kız evden çıkar [path] koşarak [manner]"=girl house-from EXITS running; Allen et al., 2007; Özçalışkan & Slobin, 1999). Importantly, Turkish speakers often express only path, leaving manner out of their motion descriptions in speech (e.g., Özçalışkan, 2009, 2016; Özçalışkan & Slobin, 2003). The *ordering* of semantic elements also shows a binary split between English and Turkish. Turkish speakers follow a *Figure-Ground-MOTION* order, placing the primary motion component at the end of a clause in their speech ("kız evden ÇIKAR"=girl [figure] house-from [ground] EXITS [motion]). In contrast, English speakers follow a *Figure-MOTION-Ground* order, placing the primary motion component in the middle of a clause (e.g., "girl [figure] RUNS out [motion] of the house [ground]") (Özçalışkan et al., 2006a).

Previous work examining the organization of motion elements in co-speech gesture found language-specific patterns in sighted English versus Turkish speakers (conflated packaging and Figure-MOTION-Ground ordering in English speakers; separated packaging, and Figure-Ground-MOTION ordering in Turkish speakers; Kita & Özyürek, 2003; Özçalışkan et al., 2016a), suggesting an online effect of language on thought. However, these language-specific patterns were *not* found in silent gesture. Sighted English and Turkish speakers displayed the same packaging (conflated, the English pattern) and ordering (Figure-Ground-MOTION, the Turkish pattern) in their silent gestures (Özçalışkan, 2016; Özçalışkan et al., 2016a), suggesting no offline effect of language on thought in this domain.

In this study, we take this finding one step further and ask whether the contrast between online versus offline effects of language on thought (as viewed through gesture) is found in congenitally blind adults. Özçalışkan et al. (2016b) examined the packaging of semantic elements in the co-speech gestures produced by congenitally blind adult English and Turkish speakers and found an online effect of language on the packaging of semantic elements in co-speech gesture. Congenitally blind English speakers produced gestures that resembled the gestures of sighted English speakers (i.e., more conflated gestures), whereas blind Turkish speakers produced gestures resembling the gestures of sighted Turkish speakers (i.e., more separated gestures). But we do not yet know whether these online effects of language extend to the ordering of semantic elements in co-speech gestures. Nor do we know whether blind adults display offline effects of language, importing the packaging and ordering patterns found in their speech into silent gesture. We fill these gaps by examining the gestures sighted and blind speakers of English and Turkish produce when describing three-dimensional motion event scenes with speech (i.e., co-speech gesture) and without it (i.e., silent gesture).

2. Method

2.1. Participants

Participants were 40 congenitally blind adults (20 native English speakers, $M_{age} = 44$, $SD = 15$; 20 native Turkish speakers, $M_{age} = 30$, $SD = 9$)[1] and 40 sighted adults in each language—20 with blindfolds (English: $M_{age} = 40$, $SD = 12$; Turkish: $M_{age} = 26$, $SD = 6$) and 20 without blindfolds (English: $M_{age} = 43$, $SD = 13$; Turkish: $M_{age} = 26$, $SD = 7$), who were comparable to the blind adults in terms of age and education within each language. All blind speakers had an ophthalmologic diagnosis of congenital blindness with light perception at best, and no other documented physical, neurological, or mental deficits. All participants received monetary compensation for their participation in the study.

2.2. Procedure

2.2.1. Data collection

Participants were interviewed individually. They were asked to describe 12 three-dimensional scenes in counter-balanced order twice—once in speech while using their hands as naturally as possible,[2] thus producing *co-speech gesture*; and once in gesture using only their hands without any speech, thus producing *silent gesture.* Each scene depicted motion of a human figure (named Eve in English, Oya in Turkish) in relation to a landmark (e.g., house, hurdle, carpet) with a particular manner (e.g., run, jump, climb) and path (e.g., toward, away, across; see Table 1). In each scene, the figure was displayed three times with varying postures to give the impression of a continuous motion with manner and path (see Fig. 1). The participants were informed that Eve/Oya would appear three times in each scene and they should describe Eve/Oya's motion as a single continuous motion. The presentation of the test scenes was preceded by two practice trials in both the co-speech and silent gesture conditions to familiarize participants with the task demands. Blind and sighted speakers with blindfolds explored the scenes with their hands without any visual exposure. The scenes were placed on a low table in front of the blind or blindfolded participant; the experimenter marked the beginning and end of each scene for the participant by guiding the participant's hand first to the beginning and then to the end of each scene, saying "this is the beginning and this is end"; participants were then allowed to explore each scene on their own with their hands as long as they needed to. Sighted speakers without blindfolds explored the scenes visually without any haptic exposure. The sighted with blindfold condition was included to explore whether preventing sighted speakers from seeing the scenes would influence their gesture and speech patterns. Participants described all scenes first in speech (with co-speech gesture) and then in silent gesture; order was not counterbalanced so as not to influence the naturalness of the gestures produced with speech.

2.2.2. Data coding

All *speech* produced in the co-speech gesture condition was transcribed and segmented into sentence units. Each sentence unit contained at least one verb and associated arguments and subordinate clauses (e.g., "Eve runs out of house; 'Oya evden çıkar'= Oya house-from exits; 'Oya evden çıkar kosarak'= Oya house-from exits running"). We also transcribed all *gestures* that accompanied each sentence unit in the co-speech gesture condition and that were produced on their own in the silent gesture condition; only gestures that conveyed characteristic motion (i.e., manner+path, path-only, manner-only) or features (i.e., figure, landmark) associated with the stimulus scenes were included in the analysis. A spoken sentence unit could be accompanied by one or more gestures (e.g., a manner gesture alone, a manner gesture followed by a path gesture); we treated all gestures that accompanied each spoken sentence unit, and all silent gestures that described a particular scene, as a gesture sentence unit.

Following earlier work (Özçalışkan et al., 2016a,b), we coded each sentence unit in speech and in gesture along two dimensions: (a) *Packaging of semantic elements* as either conflated (manner and path are both conveyed within a single spoken clause or within a single gesture) or separated (manner and path are conveyed in separate spoken clauses or in separate gestures); a sentence unit was classified as separated if it contained manner-only, path-only, or manner and path, each conveyed in a separate clause or gesture.[3] (b) *Ordering of semantic elements* as either Figure-MOTION-Ground or

Table 1
List of motion event types used in the study

Item	Type of Path	Type of Manner	Event Description
	Motion to landmark		
1	Into a landmark	Run	Run into house
2	Into a landmark	Crawl	Crawl into house
3	Into a landmark	Climb	Climb into treehouse
4	Toward a landmark	Walk	Walk toward crib
	Motion over landmark		
5	Over a landmark	Crawl	Crawl over carpet
6	Over a landmark	Jump	Jump over hurdle
7	Over a landmark	Flip	Flip over beam
8	Along a landmark	Crawl	Crawl along tracks
	Motion from landmark		
9	Out of a landmark	Run	Run out of house
10	Out of a landmark	Roll	Roll out of tunnel
11	Out of a landmark	Crawl	Crawl out of house
12	Away from landmark	Run	Run away from motorcycle

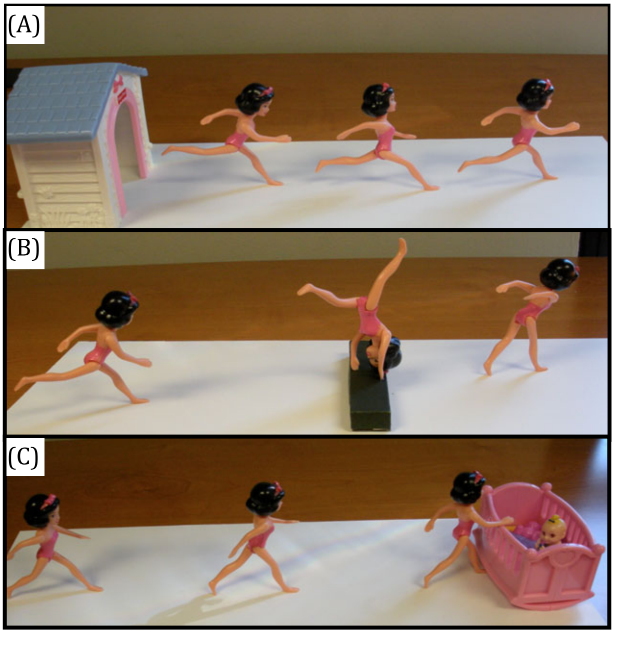

Fig. 1. Sample stimulus scenes displaying motion from a landmark (A, run out of house), over a landmark (B, flip over beam), and to a landmark (C, walk toward crib)

Figure-Ground-MOTION, according to the placement of the primary motion element—the main verb of the sentence unit, namely the word referring to typically path in Turkish or manner in English; or the gesture conveying motion, a manner gesture alone, a path gesture alone, a manner+path conflated gesture, or a sequential manner gesture followed by a path gesture (or vice versa) within a single sentence unit. Participants who conveyed multiple semantic elements in gesture tended to produce gestures for the motion and ground elements omitting a gesture for the figure; the ground element, when expressed, was typically conveyed by a stationary sideways- or upward-facing palm. For example, one participant placed a stationary sideways palm on the left = Ground; he then moved a right index finger from right to left toward the stationary palm to convey the path to the house = MOTION, that is, a (Figure)-Ground-MOTION order. As a second example, a participant wiggled her index and middle fingers from the right to the left = MOTION; she then placed her left palm in air on the left to convey running toward house = Ground, that is, a (Figure)-MOTION-Ground order. Reliability was assessed with an independent coder; agreement between coders was 94% for identifying gestures and 100% and 93% for coding motion elements in speech and gesture, respectively.

2.2.3. Data analysis

We analyzed the data by fitting generalized linear mixed-effect models with a Poisson linking function, using R (R Core Team, 2013), the glmer() function in the lme4 library (Bates, Maechler, Bolker, & Walker, 2014), and the optimx package (Nash & Varadhan, 2011). Language (English, Turkish) and Group (sighted, blindfolded, blind) were between-subjects and within-items factors. Ordering (figure-motion-ground, figure-ground-motion), Packaging (separated, conflated), and Output channel (speech, co-speech gesture, silent gesture) were within-subject and within-item factors. We treated Subject (N = 120) and Scene (N = 12) as random effects, including random intercepts for both in all analyses. We used the "Maximal" approach (Barr, Levy, Scheepers, & Tily, 2013) and included random slopes for Subject and for Scene where the data were able to support the complexity of these slope estimations (Barr, 2013). In a minority of cases, we dropped random intercepts to reduce model complexity in favor of including random slopes as this strategy provides better control of type I error rate than intercepts-only models (Barr, 2013). Our procedure was the same for all statistical tests. We first fit a model that included our four primary factors (Language, Output channel, Group, and either Packaging or Ordering) to the data. We then fit a reduced model that excluded one of the factors to the same data. Finally, we compared the relative goodness of fit of the models using a likelihood ratio test via the anova() command. This procedure compares the relative fits (expressed as log-likelihoods) of the two models to test whether the factor removed in the reduced model is statistically significant. Comparing the fits of the models in this way provides a chi-square statistic, degrees of freedom, and a p-value, all of which we report for each test.

3. Results

3.1. Packaging semantic elements

We first examined packaging of semantic elements and found the recognized cross-linguistic differences in both speech and co-speech gesture, as reflected in a significant interaction between packaging and language ($\chi^2 = 24.69$, $df = 1$, $p<.001$ for speech, $\chi^2=27.34$, $df = 1$, $p < .001$ for co-speech gesture).[4] English speakers produced more conflated motion descriptions than Turkish speakers, in both speech ($\chi^2 = 20.12$, $df = 1$, $p < .001$; $M_E = 12.43$ [$SD = 3.52$] vs. $M_T = 4.23$ [$SD = 2.\ 49$) and co-speech gesture ($\chi^2 = 16.14$, $df = 1$, $p < .001$; $M_E = 7.32$ [$SD = 4.88$] vs. $M_T = 4.22$ [$SD = 4.73$]). Conversely, Turkish speakers produced more separated motion descriptions than English speakers, in both speech ($\chi^2 = 23.24$, $df = 1$, $p < .001$; $M_T = 16.85$ [$SD = 7.08$] vs. $M_E = 7.45$ [$SD = 5.35$]) and co-speech gesture ($\chi^2 = 18.44$, $df = 1$, $p<.001$; $M_T = 14.02$ [$SD = 6.33$] vs. $M_E = 9.38$ [$SD = 8.74$]); see Fig. 2, top and middle rows. Importantly, these patterns were the same across the three groups (blind, sighted with blindfolds, sighted without blindfolds), with no reliable packaging × language × group interaction either in speech ($\chi^2 = 0.92$, $df = 2$, $p = .630$) or in co-speech gesture ($\chi^2 = 3.22$, $df = 2$, $p = .200$), suggesting that blind and sighted speakers—with or without blindfolds—display the same language-specific packaging patterns in speech and co-speech gesture, a finding reported in earlier work (Özçalışkan et al., 2016b).

Turning next to packaging of semantic elements in silent gesture, we found no reliable cross-linguistic differences in silent gesture. Considering all groups together, there was no effect of language ($\chi^2 = 0.64$, $df = 1$, $p = .422$) and no interaction between language and packaging ($\chi^2 = 0.65$, $df = 1$, $p = .419$). However, there was an overall preference for conflated packaging in silent gesture ($\chi^2 = 57.60$, $df = 1$, $p < .001$): Both English and Turkish speakers used conflated gestures significantly more often than separated gestures: $M_{conflated} = 9.23$ ($SD = 3.79$) vs. $M_{separated} = 1.90$ ($SD = 3.22$) for English speakers ($\chi^2 = 50.30$, $df = 1$, $p < .001$); $M_{conflated} = 8.65$ ($SD = 3.91$) vs. $M_{separated} = 2.0$ ($SD = 3.58$) for Turkish speakers ($\chi^2 = 53.08$, $df = 1$, $p < .001$), see Fig. 2, bottom row. The groups also did not differ in the amount of silent gestures that they produced ($\chi^2= 0.33$, $df = 2$, $p = .847$).

Importantly, our analysis also showed a significant group x language x packaging interaction ($\chi^2 = 9.40$, $df = 2$, $p < .001$), suggesting that the packaging pattern varied across groups and languages. We further unpacked the three-way interaction by testing the effect of packaging for each group within each language (e.g., conflated vs. separated packaging by English blind speakers). Our findings showed that speakers within each group and language reliably preferred conflated over separated packaging in their silent gestures (ps $< .05$); the only exception was blind Turkish speakers, who showed the same preference for conflated over separated gestures, but at a level below significance ($\chi^2 = 2.26$, $df = 1$, $p = .133$). We also examined whether speakers' preference for each packaging type within each group varied by language (e.g., conflated gestures by English blind speakers vs. conflated gestures by Turkish blind speakers). Our analysis found no effect of language for either separated or conflated packaging strategies in silent gesture within each group (ps $> .05$); the only exception was separated packaging in sighted speakers without blindfolds, where English sighted speakers without blindfolds produced more separated silent gestures than Turkish sighted speakers without blindfolds ($\chi^2 = 6.45$, $df = 1$, $p = .011$). Even though there

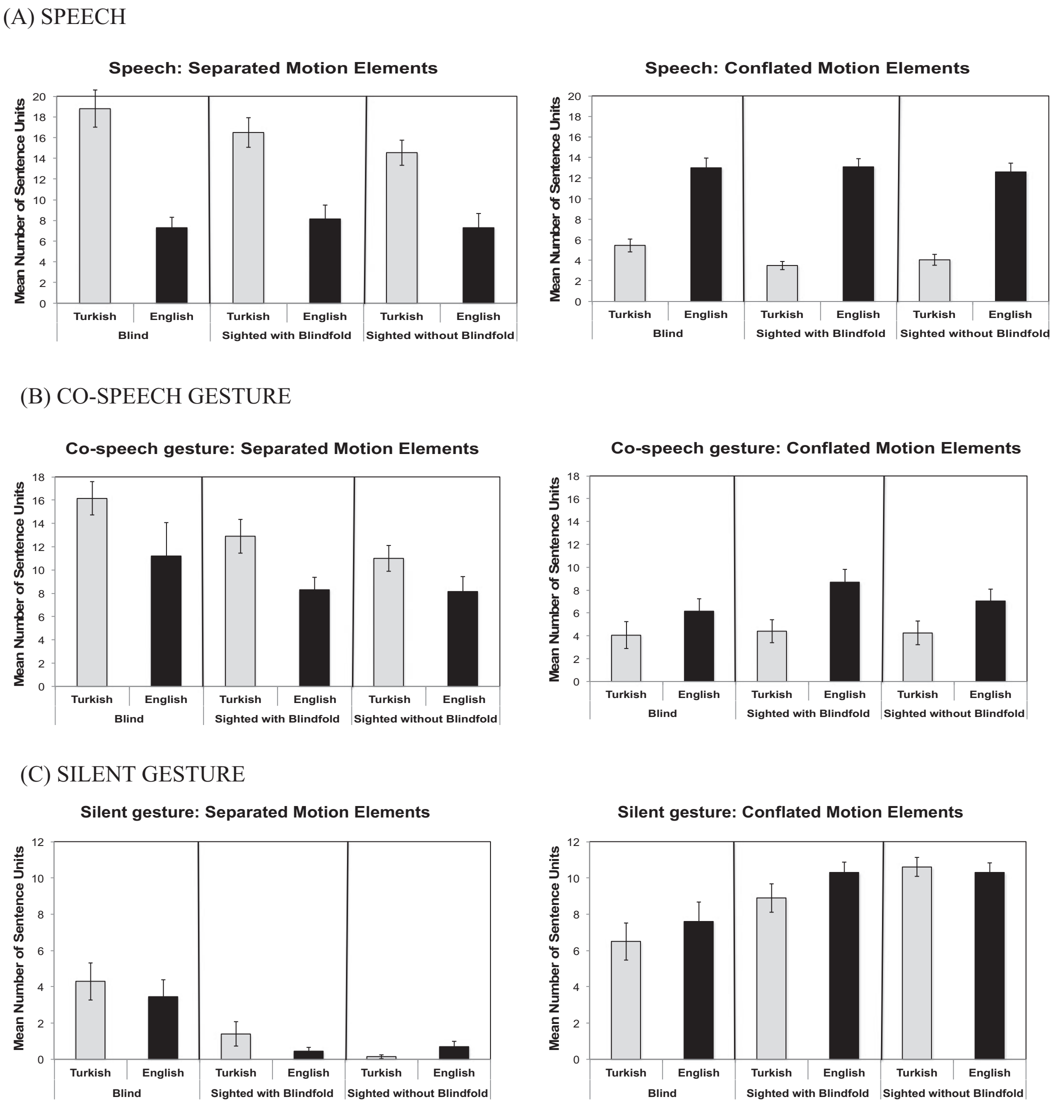

Fig. 2. Mean number of sentence units with separated (manner-only, path-only, manner-path) or conflated (manner+path in a single clause or gesture) motion elements in speech (A), in gesture with speech (co-speech gesture, B), and in gesture without speech (silent gesture, C). Turkish and English participants differ in both speech and co-speech gesture, but not in silent gesture—a pattern that held across all three groups within each language. Error bars represent standard error.

were minor variations in packaging across the groups and languages, the dominant pattern was for blind and sighted gesturers in both languages to produce silent gestures that were conflated.

3.2. Ordering semantic elements

Turning next to the order of semantic elements, we again found the recognized cross-linguistic differences in both speech and co-speech gesture (see Fig. 3), as reflected in a significant interaction between order of semantic elements and language, $\chi^2 = 28.86$, $df = 1$, $p < .001$, for speech; $\chi^2 = 22.61$, $df = 1$, $p < .001$, and for co-speech gesture.[5] English speakers produced the Figure-MOTION-Ground order more often than Turkish speakers in speech ($M_E = 17.25$ [$SD = 6.31$] vs. $M_T = 0.47$ [$SD = 0.85$], $\chi^2 = 49.96$, $df = 1$, $p < .001$) and co-speech gesture ($M_E = 1.07$ [$SD = 1.55$] vs. $M_T = 0.23$ [$SD = 0.46$], $\chi^2 = 12.73$, $df = 1$, $p < .001$). Conversely, Turkish speakers produced the Figure-Ground-MOTION order more often than English speakers in speech ($M_T = 18.05$ [$SD = 6.63$] vs. $M_E = 0.08$ [$SD = 0.33$], $\chi^2 = 21.00$, $df = 1$, $p < .001$) and co-speech gesture ($M_T = 4.91$ [$SD = 5.63$] vs. $M_E = 2.67$ [$SD = 3.48$], $\chi^2 = 9.88$, $df = 1$, $p = .002$); see Fig. 3A and B. The ordering of semantic elements in co-speech gesture showed no effect of group ($\chi^2 = 3.81$, $df = 2$, $p = .149$) but did display a group × language × order interaction ($\chi^2 = 15.48$, $df = 2$, $p < .001$), suggesting that the language x ordering interaction varied by group. However, follow-up analysis of language x ordering interaction showed the same pattern for each group individually (*p*s < .05 for all three groups). That is, blind speakers of English or Turkish ordered their co-speech gestures as did sighted speakers—with or without blindfolds—of each language. Ordering semantic elements in speech also showed a marginal effect of group ($\chi^2 = 5.88$, $df = 2$, $p = .052$), but no interaction between group × language × ordering ($\chi^2 = 0.89$, $df = 2$, $p = .641$), thus further indicating that the cross-linguistic pattern of speech ordering did not vary across the three groups.

We next examined the ordering of semantic elements in silent gesture. We found no effect of language, $\chi^2 = 2.35$, $df = 1$, $p = .125$, but a significant interaction between language and order of semantic elements, $\chi^2 = 19.88$, $df = 2$, $p < .001$. To unpack this two-way interaction, we made pairwise contrasts of the two orders within each language. We found that English and Turkish speakers strongly favored the figure-ground-MOTION ordering in their silent gestures ($\chi^2 = 24.25$, $df = 1$, $p < .001$ for English speakers, $\chi^2 = 22.89$, $df = 1$, $p < .001$ for Turkish speakers); further analysis of the figure-ground-MOTION ordering indicated no significant differences between English and Turkish ($\chi^2 = 0.01$, $df = 1$, $p = .935$). Interestingly, the language x order interaction was driven by a difference in the relatively infrequent figure-MOTION-ground ordering ($\chi^2 = 17.08$, $df = 1$, $p < .001$)—an order that was used only 8.7% of the time across the two languages; English speakers displayed greater use of the figure-MOTION-ground ordering than Turkish speakers. Finally, we tested to see whether the language x ordering interaction varied across the three groups, but found no language × order × group interaction ($\chi^2 = 4.97$, $df = 2$, $p = .083$); the strongly preferred Figure-Ground-MOTION pattern in silent gesture ordering thus did not vary across the three groups.

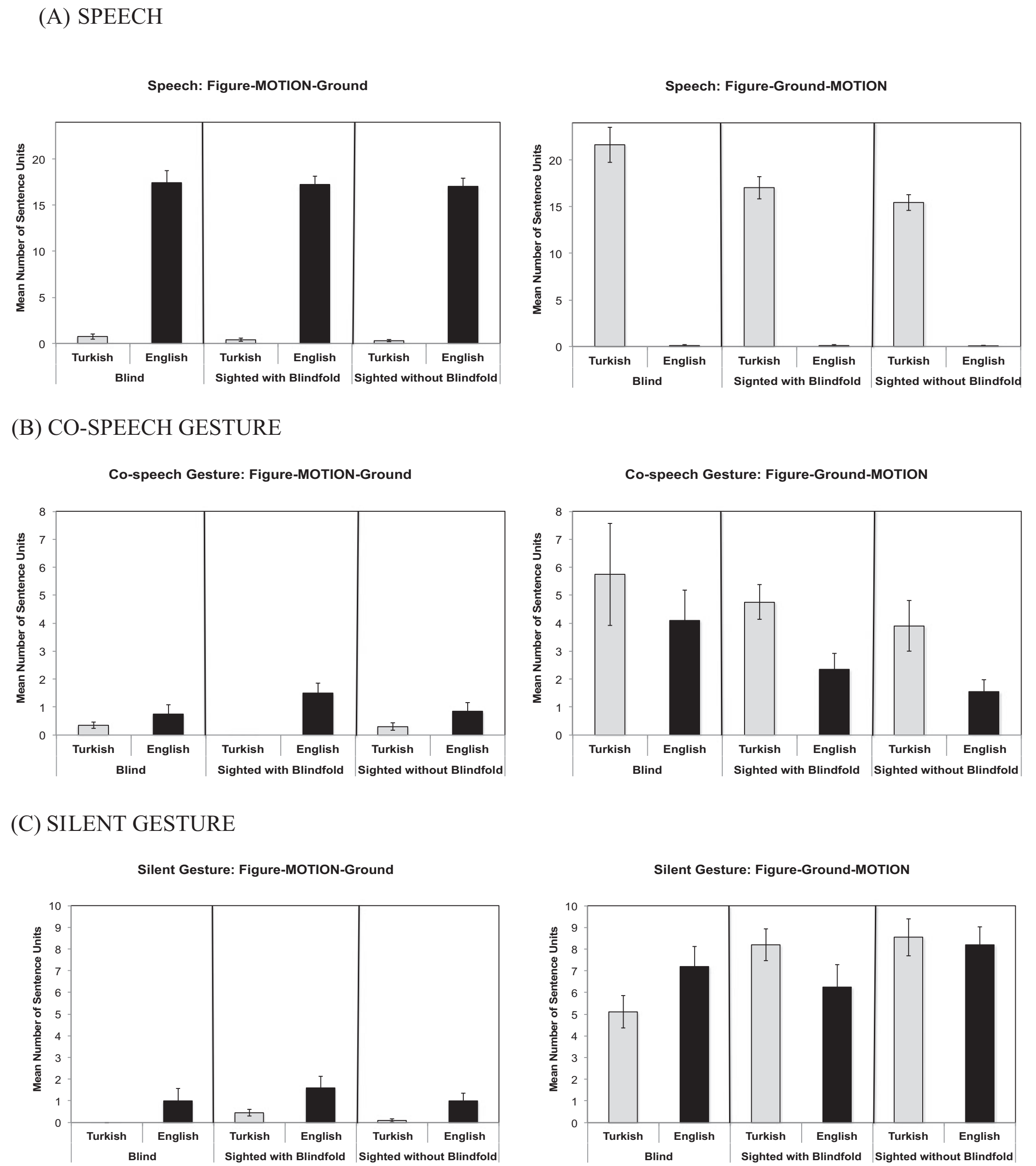

Fig. 3. Mean number of sentence units that follow Figure-MOTION-Ground or Figure-Ground-MOTION orders in speech (A), in gesture with speech (co-speech gesture, B), and in gesture without speech (silent gesture, C). Turkish and English participants differ in both speech and co-speech gesture, but not silent gesture—a pattern that held across all three groups within each language. Error bars represent standard error.

4. Discussion

Sighted speakers display cross-linguistic differences in gesture when those gestures are produced with speech, but not when they are produced without speech, that is, in silent gesture (Özçalışkan et al., 2016a). In this study, we examined the source of the cross-linguistic similarity in silent gesture, asking whether it is driven by the visuospatial characteristics of the event, or by a natural semantic organization that humans resort to when describing events without language. We found that the speaker's language had an effect on gesture when those gestures were produced with speech—co-speech gestures of English speakers (blind, sighted with/without blindfolds) differed from co-speech gestures of Turkish speakers, and followed patterns found in speech. However, the speaker's language had no effect on gesture when those gestures were produced on their own—silent gestures produced by English speakers, including blind speakers, resembled silent gestures produced by Turkish speakers. These findings provide evidence for a natural semantic organization that humans impose on motion events when conveying the events without language—an organization that relies on neither visuospatial cues nor language structure. Our results thus extend Slobin's (1996) thinking-for-speaking hypothesis—that language has online, but not offline, effects on thought (as assessed here through gesture)—to congenitally blind speakers.

4.1. Ordering semantic elements

When not speaking, both Turkish and English speakers in our study—blind and sighted—preferred the Figure-Ground-MOTION (SOV) order in their silent gestures (the Turkish pattern). Why do speakers, particularly English speakers who use Figure-MOTION-Ground in speech and, to some extent, co-speech gesture, resort to Figure-Ground-MOTION in silent gesture? One possibility is that Figure-Ground-MOTION reflects a natural way for humans to organize events, at least when communicating about those events. Figure and ground refer to entities; motion conveys a relation between these two entities. Setting up the entities before conveying the relation between them might decrease processing load and serve as an effective communicative strategy (Gentner, 1982), particularly in silent gesture where neither the entities nor the motion that connects them are grammatically marked to indicate their relation to one another.

Emergent sign languages, such as Nicaraguan Sign Language (Senghas, Coppola, Newport, & Supalla, 1997) and Al-Sayyid Bedouin Sign Language (Sandler, Meir, Padden, & Aronoff, 2005), also use predicate-final orders (SOV) despite the fact that these emerging languages are surrounded by spoken languages with SVO word order (Sandler et al., 2005). A preference for predicate-final (SOV) order has also been reported in the silent gestures produced by speakers of languages with a variety of word orders (e.g., Spanish, English, Chinese, Turkish; Goldin-Meadow, So, Özyürek, & Mylander, 2008). Gibson et al. (2013) replicated these findings in speakers of English, Japanese, and Korean; all silent gesturers used SOV when asked to communicate about two entities that are not reversible (boy kicking ball). However, when asked to describe reversible entities (boy kicks girl), the silent gesturers resorted to SVO.

Gibson et al. (2013) argue that speakers have a default SOV word-order preference, but the desire to maximize meaning recoverability in the face of possible noise can alter this default pattern. In the case of two animate entities, sensitivity to the ambiguity of having two plausible agents encourages silent gesturers to split the entities up and put one on each side of the verb. The scenes in our study all involved an animate entity moving in relation to an inanimate location. The Figure-Ground-MOTION order that we found in all participants' silent gestures might thus reflect the default SOV pattern.

4.2. Packaging semantic elements

When not speaking, the Turkish and English speakers in our study—blind and sighted—also preferred conflated packaging (the English pattern) in their silent gestures. Unlike speech, which typically requires relatively complex linguistic constructions (a complement or a subordinate clause) to convey manner and path within a single sentence unit, gesture offers a single form that makes it easy to convey both components simultaneously (e.g., rotating the hand [manner] while moving it forward [path]). If silent gesturers are not going to choose a packaging pattern based on their spoken language, they might resort to this conflated gesture, which has the advantage of conveying all of the needed information within a single form. Even in speech Turkish speakers often choose to use a form that is atypical for Turkish—manner and path conveyed within a single lexical item—if the option exists for the event they are describing (Özçalışkan & Slobin, 2000). Thus, the conflated form in silent gesture may grow out of a pressure to convey the maximal amount of information with limited effort.

Importantly, we found that the patterns observed in silent gesture with respect to packaging motion elements (conflated, the English pattern) and ordering them (Figure-Ground-MOTION, the Turkish pattern) arise not only in sighted speakers (as shown in previous work, Özçalışkan et al., 2016a), but also in blind speakers. Unlike sighted speakers, blind speakers do not have visual access to the spatial configuration of these events and thus might have imported into silent gesture the patterns they use when describing these events in speech (and co-speech gesture). But they did not. Instead, they use the same patterns that sighted speakers use, patterns that do *not* mirror the patterns in the speakers' language. Our study thus provides no evidence for an offline effect of language on nonverbal representation of events—even in the absence of visual access to the structure the events. Humans appear to have a natural semantic organization, one that is not derived from language, that they impose on events when conveying them nonverbally in gesture.

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Notes

1. Two of the American and three of the Turkish blind participants lost their vision between ages 1 and 3; the remaining 35 were either born blind (N = 32) or became blind within the first few months following birth (N = 3).
2. Our decision to explicitly ask our participants to gesture was based on pilot work showing a great deal of variability in gesture rates across individuals and, importantly, lower rates of overall gesture production in blind speakers than in sighted speakers. Asking participants to gesture in the co-speech condition allowed us to maximize the chances of attaining equal numbers of blind and sighted participants who gestured in each of our two languages. Our decision to provide explicit instruction to gesture was supported by previous work showing that telling speakers to gesture on a task increased the number of gestures they produced, but did not change the nature of those gestures (Cook et al., 2010; Özçalışkan, Lucero, & Goldin-Meadow, 2016a,b).
3. Turkish speakers occasionally used a third strategy in speech, combining a neutral verb (e.g., *go, move*) with a path satellite and manner in a subordinate second clause (e.g., *Oya kosarak evden gitti* = Oya went from the house running). These instances were included in the separated category.
4. We did not find an effect of packaging for speech, (χ^2 = 2.95, df = 1, p = .086), but we did for co-speech gesture (χ^2 = 9.78, df = 1, p = .002). We found no main effect of language for either speech (χ^2 = 0.92, df = 1, p = .338) or co-speech gesture (χ^2 = 2.23, df = 1, p = .135), and no effect of group either in speech (χ^2 = 2.70, df = 2, p = .259) or in co-speech gesture (χ^2 = 4.26, df = 2, p = .119).
5. We found a significant main effect of ordering for co-speech gesture (χ^2 = 31.03, df = 1, $p \leq .001$) and for speech (χ^2 = 5.19, df = 1, p = .023); there was no main effect of language for either speech (χ^2 = 0.97, df = 1, p = .325) or co-speech gesture (χ^2 = 2.76, df = 1, p = .097).

References

Allen, S., Özyürek, A., Kita, S., Brown, A., Furman, R., Ishizuka, T., & Fujii, M. (2007). Language-specific and universal influences in children's syntactic packaging of Manner and Path: A comparison of English, Japanese and Turkish. *Cognition*, *102*, 16–48.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2014). lme4: Linear mixed-effects models using 'Eigen' and S4 [R Package Version 1.0-6]. Retrieved from http://CRAN.R-project.org/package=lme4

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language*, *68*, 255–278.

Cook, S. W., Yip, T. K., & Goldin-Meadow, S. (2010). Gesturing makes memories that last. *Journal of Memory and Language*, *63*(4), 465–475.

Gentner, D. (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. A. Kuczaj (Ed.), *Language development: Vol. 2, Language, thought and culture* (pp. 301–334). Hillsdale, NJ: Erlbaum.

Gibson, E., Piantadosi, S. T., Brink, K., Bergen, L., Lim, E., & Saxe, R. (2013). A noisy-channel account of crosslinguistic word order variation. *Psychological Science*, *24*(7), 1079–1088.

Goldin-Meadow, S., So, W. C., Ozyurek, A., & Mylander, C. (2008). The natural order of events: How speakers of different languages represent events nonverbally. *PNAS*, *105*(27), 9163–9168.

Kita, S., & Özyürek, A. (2003). What does crosslinguistic 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*(1), 16–32.

Nash, J. C., & Varadhan, R. (2011). Unifying optimization algorithms to aid software system users: Optimx for R. *Journal of Statistical Software*, *43*(9), 1–14.

Özçalışkan, Ş. (2009). Learning to talk about spatial motion in language-specific ways. In J. Guo, E. Lieven, S. Ervin-Tripp, N. Budwig, K. Nakamura & Ş. Özçalışkan (Eds.), *Cross-linguistic approaches to the psychology of language: Research in the tradition of Dan Isaac Slobin* (pp. 263–276). New York: Psychology Press.

Özçalışkan, Ş. (2016). Do gestures follow speech in bilinguals' description of motion? *Bilingualism: Language and Cognition*, *19*(3), 644–653.

Özçalışkan, Ş., Lucero, C., & Goldin-Meadow, S. (2016a). Does language shape silent gesture? *Cognition*, *148*, 10–18.

Özçalışkan, Ş., Lucero, C., & Goldin-Meadow, S. (2016b). Is seeing gesture necessary to gesture like a native speaker? *Psychological Science*, *27*(5), 737–747.

Özçalışkan, Ş., & 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 Boston University Conference on Language Development* (pp. 541–552). Somerville, MA: Cascadilla Press.

Özçalışkan, Ş., & Slobin, D. I. (2000). "Climb up" vs. "ascend climbing": Lexicalization choices in expressing motion events with manner and path components. In S. Catherine.-Howell, S. A. Fish, & K. Lucas (Eds.), *Proceedings of the 24th Boston University Conference on Language Development* (pp. 558–570). Somerville, MA: Cascadilla Press.

Özçalışkan, Ş., & Slobin, D. I. (2003). Codability effects on the expression of manner of motion in English and Turkish. In A. S. Özsoy, M. Nakipoglu-Demiralp, & E. Erguvanlı-Taylan, & A. Aksu-Koç (Eds.), *Studies in Turkish linguistics* (pp. 259–270). Istanbul: Bogaziçi University Press.

R Core Team. (2013). R: A language and environment for statistical computing (Version 3.0.2) [Computer software].Vienna, Austria: R Foundation for Statistical Computing.

Sandler, W., Meir, 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., Coppola, M., Newport, E. L., & Supalla, T. (1997). *Argument structure in Nicaraguan Sign Language: The emergence of grammatical devices*. In E. Hughes, M. Hughes, & A. Greenhill (Eds.), BUCLD 21: Proceedings of the 21st Annual Boston University Conference on Language Development (pp. 550–561). Boston: Cascadilla Press.

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

Talmy, L. (1985). Semantics and syntax of motion. In J. Kimball (Ed.), *Syntax and semantics*. Vol. 4 (pp. 181–238). New York: Academic Press.

Talmy, L. (2000). *Toward a cognitive semantics: Typology and process in concept structuring*. Cambridge, MA: The MIT Press.