



Does brain injury impair speech and gesture differently?

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People often use spontaneous gestures when talking about space, such as when giving directions. In a recent study from our lab, we examined whether focal brain-injured individuals' naming motion event components of manner and path (represented in English by verbs and prepositions, respectively) are impaired selectively, and whether gestures compensate for impairment in speech. Left or right hemisphere damaged patients and elderly control participants were asked to describe motion events (e.g., walking around) depicted in brief videos. Results suggest that producing verbs and prepositions can be separately impaired in the left hemisphere and gesture production compensates for naming impairments when damage involves specific areas in the left temporal cortex.

People use motion verbs and syntactic helpers such as prepositions and adverbs to describe spatial events and organize relational thinking (Chatterjee, 2008). When describing spatial events, such as running through the forest or giving directions, we use spontaneous hand gestures that augment communication. In a recent study from our lab (Göksun, Lehet, Malykhina & Chatterjee, 2015), we examined (1) the neural organization of spatial language and spatial gestures by investigating different event components and (2) the relation between impaired spatial speech and gesture use.



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A dynamic spatial event represented by a motion verb has several components: figure, ground, path, and manner (Talmy, 2000). Figure refers to a particular point in space which moves with respect to a reference

Speech

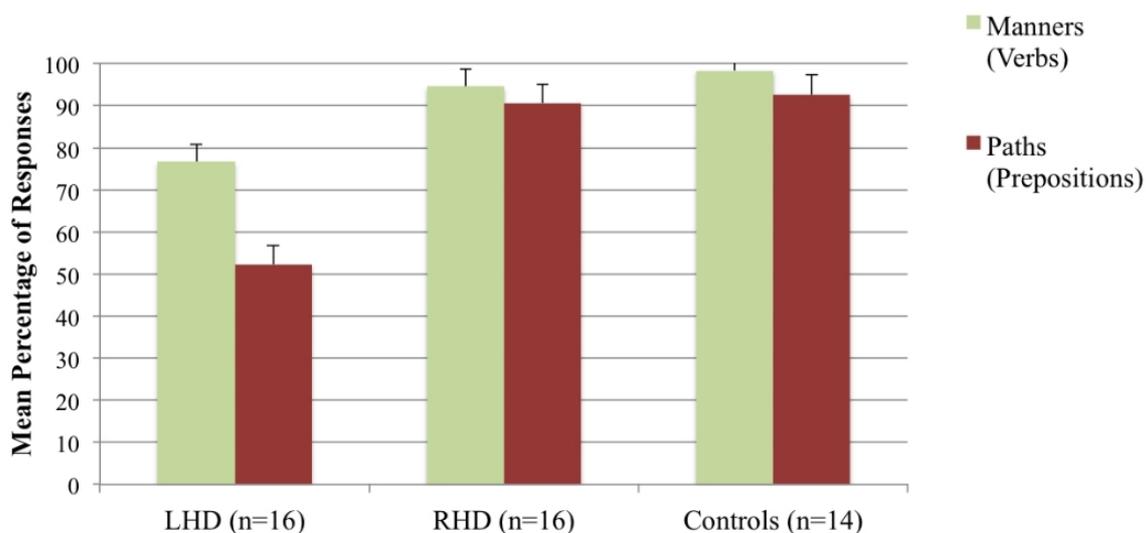


Figure 1.- Percentage of trials on which LHD patients ($n=16$, M age = 65, 10 females), RHD patients ($n=16$, M age = 64, 11 female), and healthy control participants ($n=14$, M age = 61, 9 females) correctly named manners (verbs) and paths (prepositions).

point, which is the ground. Path of motion refers to a figure's trajectory relative to the ground and manner of motion refers to how the action is performed (e.g., in "jumping over a bench", "jumping" expresses manner and "over" communicates path). Languages differ in how they encode path and manner in events. In English, manner is expressed most often by the main verb and path is by a verb particle or a satellite (e.g., "he run out of the house"), whereas in Turkish or Spanish path is expressed in the main verb and manner in a verb complement, if any (e.g., "koşarak evden çıktı", literally "exiting the house runningly"; in Spanish, "salió de la casa corriendo").

When observing an event, attention to path and manner of motion activates different neural networks in English speaking adults (Wu, Morganti & Chatterjee, 2008). In particular, dorsal areas (i.e., bilateral posterior parietal and frontal areas) are preferentially activated by changes in path of motion whereas relatively ventral areas (i.e., bilateral posterior inferior/middle temporal cortex) are specially activated by manner changes. This neural differentiation is also observed when people listen to or talk about linguistic descriptions of path and manner by prepositions and verbs (e.g., Amorapanth et al., 2009; Göksun et al., 2013). Thus, spatial perception and spatial language have a parallel organizational structure within the brain (Chatterjee, 2008).

Verbal information is not the only way people express spatial information. Spontaneous gestures are limb movements that can also express the content of spatial language. Speech and gesture form a coherent and interrelated representational system (McNeill, 1992), yet whether they originate from the same neural system is not clear (e.g., Kita & Özyürek, 2003). Recently, we (Göksun et al., 2015) addressed the question of the dissociability of speech and gesture by looking at patients with brain damage. If speech and gesture originate from the same neural system, problems in each system would co-occur. In contrast, if speech and gesture are generated from different but interrelated systems, problems in speech would not always lead to problems in gesture. In this case, spontaneous gestures might be used as a compensatory mechanism for verbal impairments.

We tested 32 English-speaking patients with left (LHD) or right hemisphere damage (RHD) and 14 healthy controls matched in age. Participants described motion events (e.g., "the woman runs across the street"), depicted in brief videos (22 trials). Different combinations of 10 manners (e.g., hop, skip, cartwheel, twirl) and nine paths (through, to, under) were used.

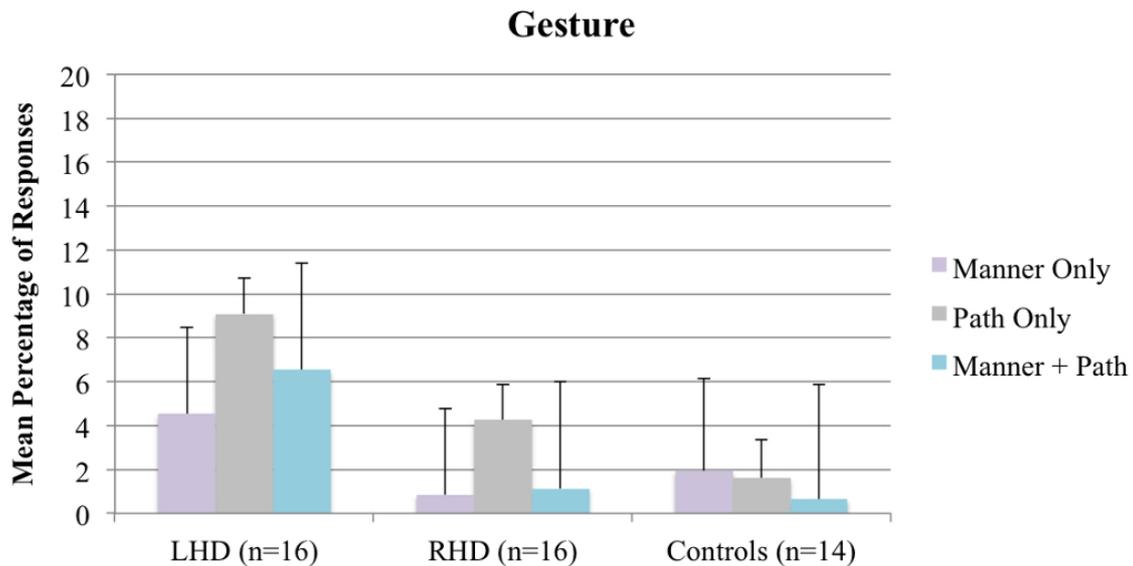


Figure 2.- Percentage of trials on which manner only, path only and manner + path gestures were produced by each group.

We coded the accuracy of verb (manner) and preposition (path) in each trial. For the gestures, we coded dynamic gestures (e.g., moving the hand from left to right) and classified them into: (1) manner only (e.g., repetitive up and down movement of index and middle fingers without any forward motion meaning to run); (2) path only (e.g., palm facing down moves straight from left to right to represent across); and (3) manner + path together (e.g., moving a hand forward while repetitively moving the index and middle fingers to represent to run over). Finally, we coded whether patients produced the same information in gesture and speech or additional/compensatory gestures (appropriate gesture with inaccurate or absent verbal information). In addition to behavioral analyses, we used voxel-based lesion symptom mapping (VLSM) to assess correlations between impaired speech and brain lesions as well as gesture use and brain lesions. VLSM offers specificity to lesion analysis by increasing the possibility of detecting neural correlates related to behavior that might not be evident in traditional lesion mapping methods. In this technique, patients are not classified based on clinical diagnosis, lesion site or behavioral performance.

Results indicated that patients with left hemisphere damage (LHD) were less accurate than both the right hemisphere damaged (RHD) patients and control participants in both naming manners (verbs) and paths (prepositions). LHD patients were also worse in naming paths than manners. The LHD patients omitted path expressions more than other groups (see Figure 1). In general, patients produced more gestures as the problems in speech increased, with path only gestures being most common (Figure 2).

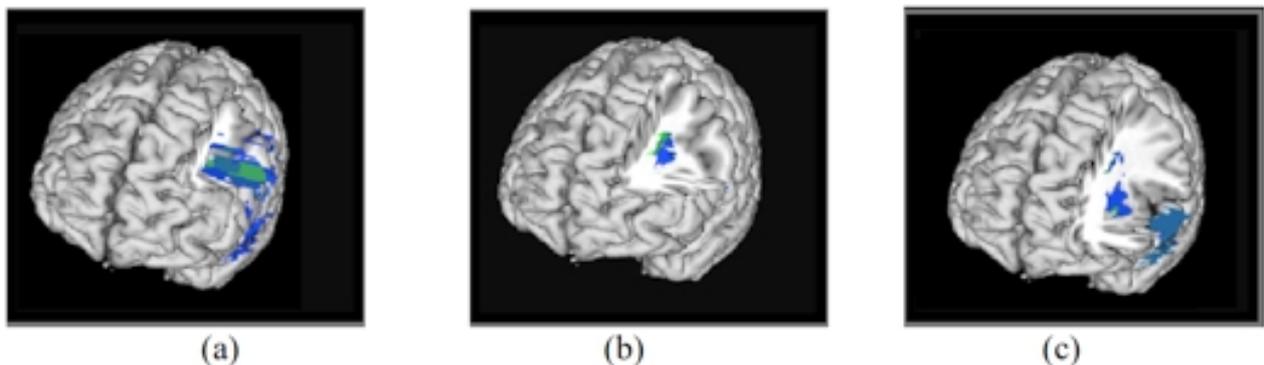


Figure 3.- Representative slice from lesion-behavior analyses for naming (a) path of motion, (b) manner of motion, and for (c) producing path only gestures.

We found significant and different lesion-symptom relations for deficits in producing manner expressions (verbs) and path expressions (prepositions) (Figure 3a and 3b). Lesions to the left posterior middle frontal gyrus, the left inferior frontal gyrus, and the left anterior superior temporal gyrus (aSTG) were linked to problems in naming paths, whereas lesions to the left caudate and white matter underlying middle frontal gyrus were associated with impairments in naming manners. For gestures, patients with lesions to the left aSTG significantly produced more path only gestures than those that did not have lesions in this location (Figure 3c).

These findings suggest that the neural organization of naming different motion event components (path and manner) differs. People can have selective impairment of one component and manner is less affected than path. Patients can express their intact conceptual knowledge by using spontaneous spatial gestures to compensate for their verbal problems. This suggests that specialized treatments that encourage gesturing for lexical retrieval might enhance impaired communication abilities in these patients.

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