Supplemental Analysis

Experimental Details

In the Beat Gesture+Specific Language condition, each narrative was accompanied by three beat gestures (e.g., a slight flicking of one or both hands, or a short downward stroke of a closed palm). Beat gestures were matched with iconic gestures to the extent that they were performed at the same points in the stories, and with the same number of hands as the corresponding iconic gestures.

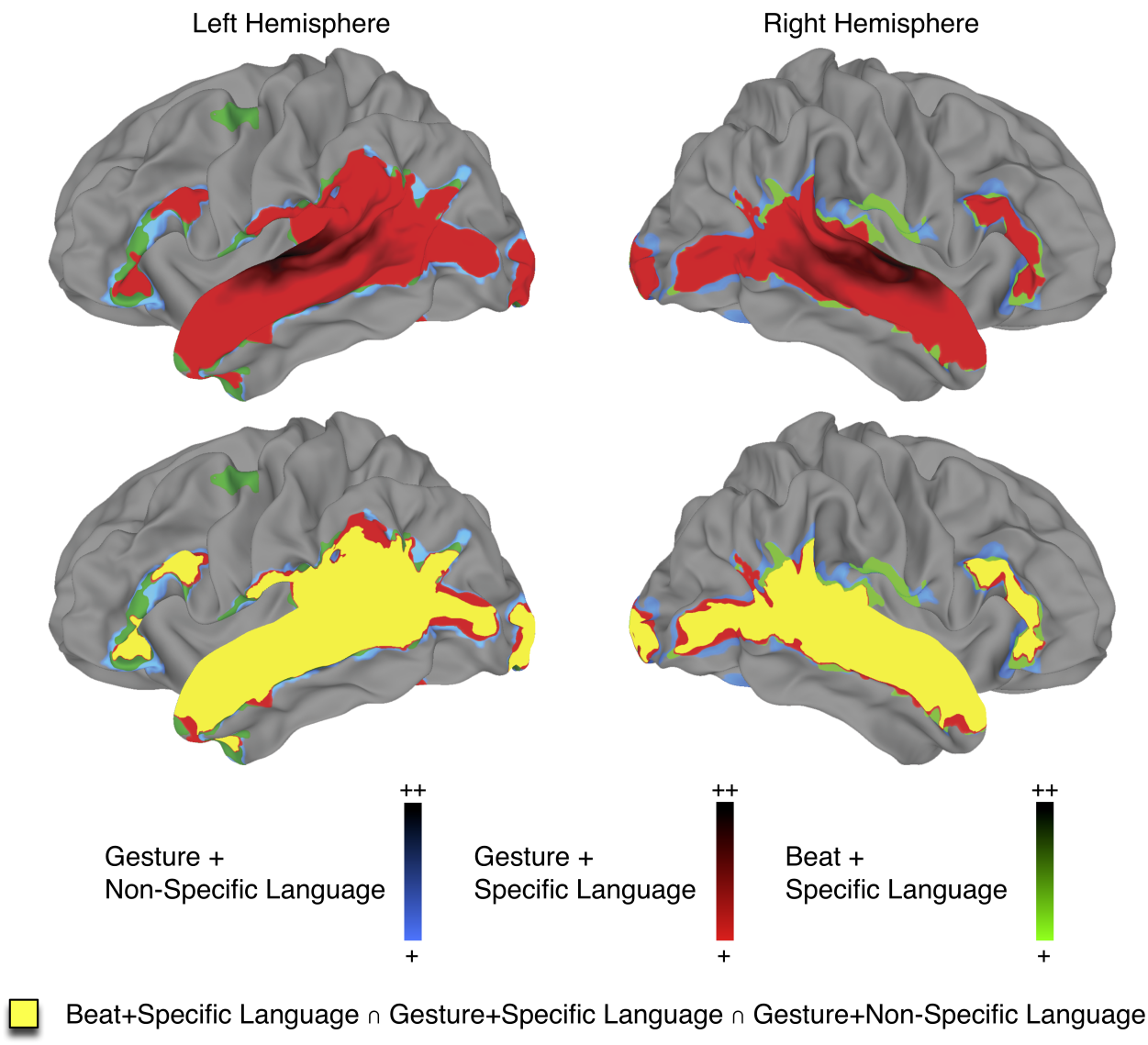
Analysis Details

The goal of this analysis was to establish which brain regions respond to speech with gesture, independent of the semantic relation between the gesture and speech (i.e., beat gestures, redundant iconic gestures, supplemental iconic gestures). To address this, we conducted an intersection (logical conjunction) analysis. Using the statistical parametric maps from the analysis against a resting baseline, we analyzed the common activation pattern engaged when processing speech with gestures (both iconic and beat gestures), independent of the semantic relation between the gestures and speech. This consisted of the following intersection: *Gesture* > *Baseline* or (*Beat Gesture+Specific Language* ∩ *Gesture+Specific Language* ∩ *Gesture+Non-specific Language*). "Conjunction" was defined as the intersection of those vertices with significant activity (corrected) against resting baseline across the examined conditions (Nichols et al., 2005).

Results

Supplementary Figure 1 presents the intersection analysis. In that figure, the above-baseline activity for each gesture condition is presented, as well as the intersection of all three conditions (yellow). A set of "core" regions responded regardless of the type of gesture (yellow),

and these regions were comprised of most of the superior and middle temporal cortex, extending into the inferior parietal lobe, and into the extrastriate and striate cortex of the occipital lobe. There were also points of overlap in bilateral IFG. In the right IFGTr extending into the more anterior *pars orbitalis* (IFGOr), there was overlap across all three conditions. In the left IFGTr, the activation profile was very similar for iconic Gesture+Non-specific Language (blue) and Beat Gesture+Specific Language (green). In contrast, the Gesture+Specific Language (red) condition did not elicit activity in the middle portion of the *pars triangularis*. Beat gestures also elicited greater activity in the superior portion of the ventral premotor cortex.



Supplementary Figure 1. Results of the intersection of all conditions with hand movements: Beat+Specific Language ∩ Gesture+Specific Language ∩ Gesture+Non-Specific Language. Top shows the activation profile for each condition ($p < .05$, corrected). Bottom overlays the intersection of these conditions (in yellow).

Discussion

Prior research has pointed to a core network of temporal and inferior parietal brain regions that activates in response to narrative language, whether it is accompanied by beat

gestures, iconic gestures, or no gestures at all. Additional regions, including inferior frontal and lateral regions and medial occipital regions, respond to iconic gestures that accompany speech. Notably, the most anterior part of the IFG, corresponding to the *pars orbitalis*, is responsive to beat gestures, consistent with the findings from Hubbard and colleagues (2008) who showed that, relative to a still body baseline condition, the anterior part of both left and right IFG responded to beat gestures accompanying speech. In fact, our data are very similar to the data they report in their Figure 2, which shows brain activation in response to viewing beat gestures with speech. Our supplemental analysis largely replicates these findings, as well as those showing that gestures influence the neural response in brain regions involved in processing language (Bates and F. Dick, 2002; A. Dick et al., 2012).

References

Bates E, Dick F (2002): Language, gesture, and the developing brain. Dev Psychobiol 40:293-310.

Dick AS, Goldin-Meadow S, Solodkin A, Small SL (2012): Gesture in the developing brain. Dev Sci 15:165-180. DOI: 10.1111/j.1467-7687.2011.01100.x