Hand Observation and Language: Emblems, Speech, & Grasping

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Introduction

- Emblems are a class of intended manual gestures that have symbolic meaning independent of accompanying language (e.g. raising the arm with a closed fist and thumb up, meaning, "It's good").

- Interpreting other goal-directed hand actions, such as grasping a useful object, may require different types of inferences that are not as closely associated with direct linguistic meaning.

- We investigated the differential neural response to (a) hand observation when used for symbolic representation (emblems) versus transitive goal-directed action (grasping); and (b) symbolic meaning with manual gestures (emblems) compared to oral speech (language)

Methods

- In an fMRI experiment (3T), twelve right-handed participants were presented with video clips of a left-handed actor performing emblems, speech, and grasping of common objects (**Figure 1**).

- Speech items were short phrases representing the meaning of the emblems, e.g., "it's good" for the thumbs-up sign.

- Participants passively observed the stimuli (i.e. no secondary task requirements). Presentation of the video clips was counterbalanced and randomized in an event-related design using a twenty-second stimulus onset asynchrony.

- Signal change was estimated using deconvolution/ regression (AFNI). Functional data were analyzed on a surface representation (Freesurfer). We performed both group analysis on the whole brain and individual regional analyses.

Results

- Indications from both the group and ROI analyses suggest a differential response in the supramarginal gyrus (SMG) during the observation of emblems as compared to the observation of grasping, possibly reflective of inferential processes oriented in observing the action and understanding it as a symbolic, language-associable message (**Figure 2; Figure 3**).

- Differences between observation of emblems and observation of grasping in both the group and ROI analyses were also found in areas associated with language comprehension along the right superior temporal region (**Figure 2; Figure 3**).

Conclusions

- The neural response to the observation of emblems seems to implicate areas that have been shown to be involved in both action observation and language processing.

- The supramarginal gyrus (SMG) is an area shown to be involved in action observation (Buccino et al, 2001) and language comprehension (Dapretto et al., 1999) in addition to being sensitive to tasks demanding language switching and phonological recoding (Price et al., 1999).

- A differential response in the SMG between observation of emblems and observation of grasping suggests a functional divergence possibly reflective of the inherent inferences made when interpreting an emblem, which requires both observation of the action and understanding its unique, linguistically-associated semantic meaning.

Figure 1. Still shots capturing the three varieties of video stimuli presented: Emblem (left), in which the left-handed actor performs an emblematic gesture (e.g. "It's good"); Speech (middle), in which the same actor speaks aloud a verbal expression corresponding to an emblem without moving his hands; and Grasping (right), in which the actor grasps a common object.

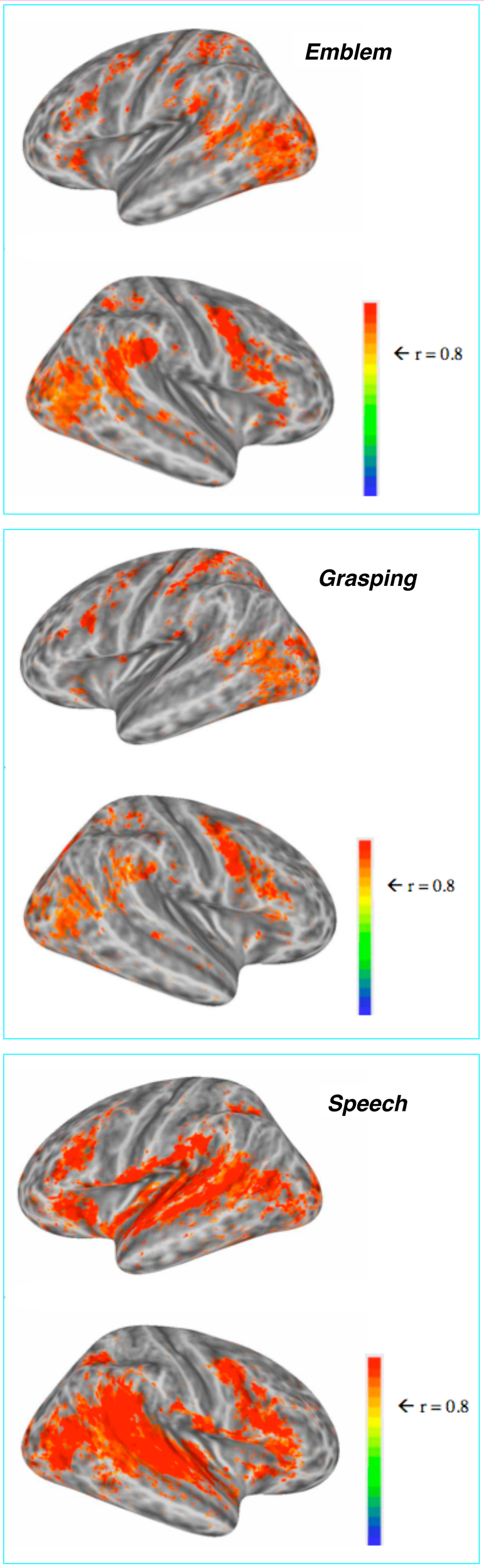

Figure 2. **Cross-Correlation with Ideal Gamma.** Surface vertex-based group analysis using a cross-correlation of the HRF with an ideal gamma waveform for each condition on a vertex by vertex basis that also incorporates the lag of maximum correlation with that ideal. Each condition here shown with zero lag (maps thresholded at $p < 0.001$, uncorrected).

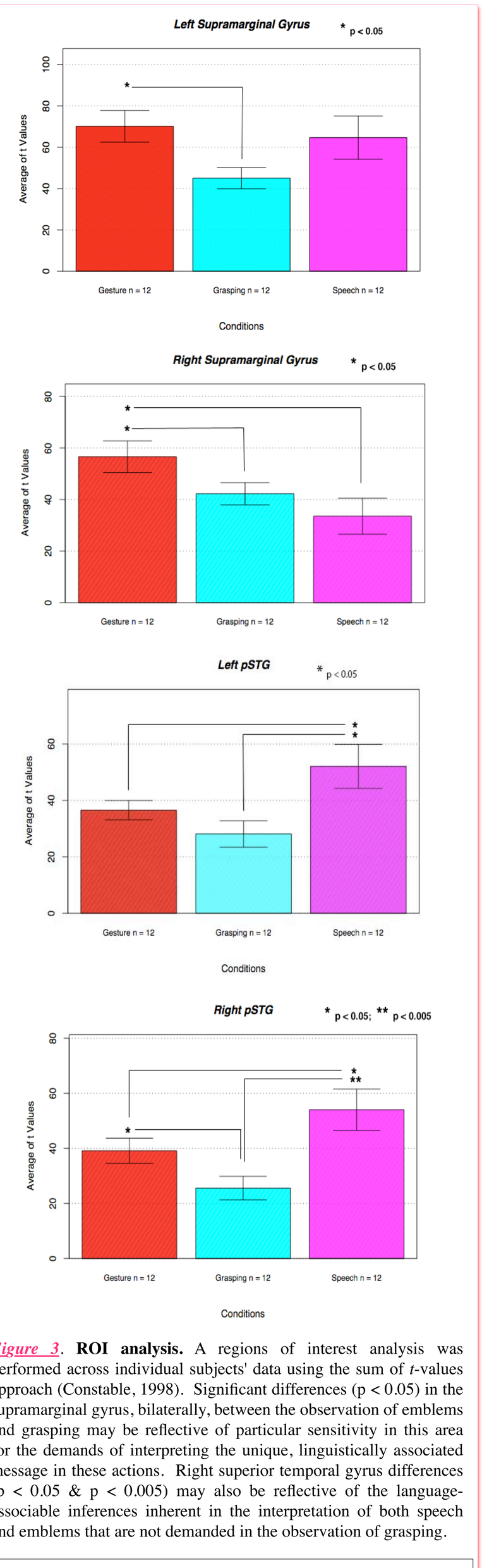

Figure 3. **ROI analysis.** A regions of interest analysis was performed across individual subjects' data using the sum of *t*-values approach (Constable, 1998). Significant differences ($p < 0.05$) in the supramarginal gyrus, bilaterally, between the observation of emblems and grasping may be reflective of particular sensitivity in this area for the demands of interpreting the unique, linguistically associated message in these actions. Right superior temporal gyrus differences ($p < 0.05$ & $p < 0.005$) may also be reflective of the language-associable inferences inherent in the interpretation of both speech and emblems that are not demanded in the observation of grasping.

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