Background
Volume-based inter-subject averaging methods fail to account for anatomical variability, requiring co-registration of functionally distinct regions and a loss of statistical power. This is particularly problematic for neuroimaging studies of speech because functionally distinct regions in the per-Sylvian region that are distant along cortical surface are proximal in the volume. Individual region of interest (ROI)-based analysis of cortical responses significantly improves statistical power (Nieto-Castanon et al., 2003) but requires lengthy, tedious labeling by an expert.

The SpeechLabel Cortical Labeling System
Regions are plotted on the Freesurfer inflated surface template for the left hemisphere. Each cortical hemisphere is divided into 63 regions of interest based on individual anatomical landmarks. Superior temporal, inferior frontal, precentral, and medial frontal regions are divided into functionally meaningful subunits for neuroimaging studies of speech. See Table 1 for region abbreviation key.

Table 1: Regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>aINS</td>
<td>aINS</td>
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<tr>
<td>aFO</td>
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<td>aITg</td>
<td>aITg</td>
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<td>aCO</td>
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<td>FP</td>
<td>FP</td>
<td>frontal pole</td>
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<tr>
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Conclusions
The SpeechLabel system divides the cortex into regions that are tailored for neuroimaging studies of speech production. The SpeechLabel atlas provides a common substrate for localizing effects within a surface-based template, including medial and inferior frontal areas. This allows for more accurate classification of speech regions and a better understanding of region/sulcal variability.

Acknowledgments
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References

Table 2: Landmarks

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Overlap of automatic and manually edited labels

PO of speech regions with PO < 75% in one of the groups subject.

Anatomical landmarks
Bounding sulci are shown on the mean surface curvature of the inflated flaverage surface template for the left hemisphere. Red (positive curvature) indicates a sulcal region, green (negative curvature) indicates a gyral region. Additional dividing landmarks include sulcal interactions and the anterior commissures. White stars indicate landmarks that are not easily viewed on the average template. See Table 2 for landmark abbreviation key.

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Methods
SpeechLabel Atlas Generation: Image segmentation, cortical surface reconstruction, surface-based co-registration, and initial surface labeling was performed on T1 MRI volumes from 17 neurologically normal subjects (9 Female, Age: 20-43, Mean: 29) using Freesurfer v5.0. T1 data acquisition: Siemens Trio 3T scanner, MPRIAGE sequence, 1mm3 voxel size.

Surface labels were edited to conform to the SpeechLabel system (editing was overseen by a trained neuroanatomical expert). The labeled surfaces were used as a training set to generate the SLaparc atlas using standard Freesurfer tools (Fischl et al. 2004).

Freesurfer’s (http://surfer.nmr.mgh.harvard.edu/) individual cortical surface-based inter-subject averaging methods (Fischl et al., 1999) improves upon volume-based methods (e.g., Ghosh et al., 2010) but packaging cortical labeling atlases fail to distinguish putative functionally distinct areas that underlie speech processes. Here, we describe a cortical labeling system tailored for neuroimaging studies of speech that was used to generate a Freesurfer atlas of T1 volumes of 18 fluent speakers and 20 persons who stutter to assess the performance of the automatic atlas.

The SpeechLabel system divides the cortex into regions that are tailored for neuroimaging studies of speech production. The SpeechLabel atlas provides a common substrate for localizing effects within a surface-based template, including medial and inferior frontal areas. This allows for more accurate classification of speech regions and a better understanding of region/sulcal variability.