

# Must the Insula Be Damaged in Apraxia of Speech?

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Broca's area has been regarded traditionally as a major center responsible for the motor programming of speech. Much of the literature has attributed the deficit of apraxia of speech (a disorder of the motor planning of speech) to a lesion of Broca's area and its environs (Darley, 1977; Kertesz et al., 1979; MacNeilage, 1998; Mohr et al., 1978). In contrast, some studies have observed apraxia of speech from isolated damage to the anterior portion of the insula (Dronkers, 1996; Nagao et al., 1999). In fact, Dronkers (1996) adheres to a strong hypothesis, which states that the insula must be damaged in order for apraxia of speech to occur. Furthermore, researchers have also reported insular involvement in several cases of Broca's aphasia (Mazzocchi & Vignolo, 1979; Mohr et al., 1978). This is note worthy because it is unknown whether the patients included in these studies exhibited a coexisting apraxia of speech with their aphasia and if so, whether this may have been attributable to insular damage.

These findings are not without dispute. Earlier studies, as well as several recent studies, have demonstrated that apraxia of speech occurs in the absence of insular damage (McNeil et al., 1990; Riecker et al., 2000). However, lack of agreement in terminology and diagnosis as well as inadequate lesion information may produce conflicting conclusions such as those presented above. Clearly, there is a need to study additional cases with apraxia of speech and aphasia to further identify their neurological bases.

## Methods

### Participants

#### Eleven cases:

- Pure apraxia of speech (2)
- Broca's aphasia and apraxia of speech (7)
- Mixed nonfluent aphasia and apraxia of speech (2)

#### Selection criteria:

- History of stroke with no other neurological or psychological deficits
- English as the primary language
- Availability of neuroimaging films obtained from computerized tomography (CT) and/or magnetic resonance imaging (MRI)
- Formal speech-language evaluation

#### Diagnostic criteria for apraxia of speech (displays at least 2):

- Effortful, trial and error, groping articulatory movements and attempts at self-correction
- Dysprosody unrelieved by extended periods of normal rhythm, stress, and intonation
- Obvious difficulty initiating utterances

### Reliability:

- Two certified speech-language pathologists naïve to the purposes of the study served as judges
- Each judge reviewed separate, pre-selected charts of participants with whom they had no previous contact
- Presented with a checklist of the defining characteristics of each disorder
- Identified at least two of the three criteria necessary for inclusion
- Interjudge reliability for presence of selection criteria was 100%

### Procedure

- CT and/or MRI scans obtained
- Scans read by four neuroradiologists to identify lesion(s) underlying speech and language deficits for each participant
- These analyses reviewed and compared for instances of agreement or disagreement by a board-certified stroke neurologist and final adjudication reading delivered

## Results

- Percentages of agreement calculated for sites of lesion
- High level of reliability suggested by 82% average level of agreement
- Majority of neuroradiologists converged on same interpretation for 9 of 11 cases

**Table 1. Final Adjudication Results**

Participant	Site of lesion
<b>Broca's aphasia with apraxia of speech</b>	
1B	Frontal, insular
2B	Predominately frontal and involving insular cortex
3B	Frontotemporal
4B	Predominately frontal, possibly separate posterior parietal and temporo-occipital
5B	Deep basal ganglia, cortical edema
6B	Frontoparietal
7B	Frontal only

#### Pure apraxia of speech

1A	Frontal with insular extension
2A	Precentral

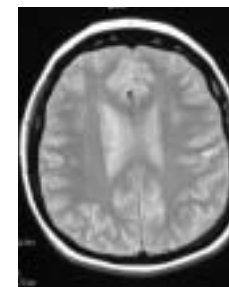
#### Mixed nonfluent aphasia with apraxia of speech

1M	Frontoparietal
2M	Basal ganglia only

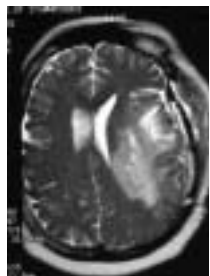
**Participant 6B**



**Participant 2A**



**Participant 1M**



- In summary, insular involvement was identified in 3 of the 11 participants (27%). These included 2 participants with Broca's aphasia and apraxia of speech, and 1 participant with pure apraxia of speech. None of the participants demonstrated an isolated lesion to the insula. No neuroanatomical structure was damaged in all 11 participants.

### ■ Limitations (with responses to each):

- Study was retrospective, thereby reducing experimental control over important variables
  - Rigorous participant selection:
    - Chart review with inspection of both formal test batteries and informal observations
    - Additional characteristics of apraxia of speech other than designated criteria noted in all participants
  - Strong reliability established among independent judges for presence of defining characteristics
- Onset of injury to date of MRI/CT was as little as one day in some cases; may have masked the true extent of the lesions in these participants
  - Neuroimaging scans completed during chronic period available for three participants
  - Insular damage absent in all three of these participants
  - Inasmuch as all of Dronkers' subjects imaged during chronic period, provides evidence that absence of insular damage in this study not simply an artifact of the time at which neuroimages collected
- Neuroimaging analyses relied on visual inspection of scans versus the sophisticated software analyses used by Dronkers
  - Four neuroradiologists, blinded to each of the others' readings, analyzed scans
  - Readings took place on separate occasions
  - Board-certified stroke neurologist offered a final adjudication
  - Extent of these procedures provide reasonable assurance that the neuroimaging findings of this study can be accepted with confidence.

## References

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## Discussion

- Dronkers' (1996) conclusions regarding the role of the insula in motor planning for speech are not supported
- Current findings are in accordance with those that do not attribute a strong role to the insula in motor speech planning but rather, recognize contributions of a more diffusely organized network