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 area and its environs (Darley, 1977; Kertesz et al., 1979; Maciariello, 1988; Mohr et al., 1986). 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) advocated 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 & Vigolo, 1979; Mohr et al., 1978). This is noteworthy 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; Emery et al., 2003). However, lack of agreement in terminology and diagnosis as well as adequate 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 imaging 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
- Dyspraxia 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 were compared and evaluated 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 88% average level of agreement
- Majority of neuroradiologists converged on same interpretation for 9 of 11 cases

Table 1. Final Adjudication Results

<table>
<thead>
<tr>
<th>Participant</th>
<th>Site of lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1M</td>
<td>Predominantly frontal and involving insular cortex</td>
</tr>
<tr>
<td>1B</td>
<td>Frontal, insular</td>
</tr>
<tr>
<td>2A</td>
<td>Predominantly frontal, posterior parietal and tempo-occipital</td>
</tr>
<tr>
<td>2B</td>
<td>Deep basal ganglia, cortical edema</td>
</tr>
<tr>
<td>3B</td>
<td>Frontoparietal</td>
</tr>
<tr>
<td>4B</td>
<td>Frontal only</td>
</tr>
<tr>
<td>5B</td>
<td>Predominantly frontal and involving insular cortex</td>
</tr>
<tr>
<td>6A</td>
<td>Predominantly frontal and involving insular cortex</td>
</tr>
<tr>
<td>6B</td>
<td>Frontoparietal</td>
</tr>
<tr>
<td>6C</td>
<td>Basal ganglia only</td>
</tr>
</tbody>
</table>

Breach aphasia with apraxia of speech

Discussion

- Dronkers’ (1996) conclusions regarding the role of the insula in motor planning for speech are not supported.

- 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 MRUCT was not ascertained in some cases; some may have missed the true extent of the lesions in these participants

- Neuroimaging scans completed during chronic period available for these participants
- Insular damage absent in all three of these participants
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- Neuroimaging and 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.