View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by The Aphasiology Archive

The Role of Brodmann Area 47 in Acute Stroke Patients with Language Impairment

Introduction

It is well understood that stroke patients with damage to left Brodmann's areas (BA) 44 and 45 suffer impaired language abilities (Mohr, Pessin, Finkelstein, Funkenstein, Duncan, Davis, 1978; Grodzinsky, 2000, Stowe, 2000). Outside of these areas, it is still not understood how other areas in left posterior frontal cortex may contribute to language. Functional imaging studies have shown activation in left BA 44 and 45 as well as activation in surrounding areas during tasks that involve syntactic processing (Caplan et al. 2000; Dapretto & Bookheimer 1999; Menenti, Petersson, Scheeringa, Hagoort, 2009). BA 47 is one of these areas, yet very little is known about its role in language processing. A recent study in chronic stroke patients (Crinion, personal communication) found that left BA 47 was implicated even more often than BA 44 and 45 in patients with chronic deficits in reading, naming, and repetition. We decided to investigate BA 47's role in acute stroke patients to see if it was responsible for these lexical deficits acutely, or if it was just an area associated with failure to recover these abilities. We hypothesized that left BA 47 would not be associated with acute deficits in reading, naming, and repetition as commonly as left BA 44 and 45. If this hypothesis were to be confirmed, the results from chronic stroke might indicate that larger strokes, involving both left BA 44/45 and 47 are associated with poor recovery of lexical functions, and that left BA 47 might be an area that can assume lexical functions when BA 44/45 are damaged if left BA 47 is not.

Methods

A consecutive series of one hundred eleven right handed patients who provided consent (or whose spouse/adult child provided consent for those with comprehension deficits) with left hemisphere ischemic stroke were tested within 48 hours of acute stroke onset. We obtained diffusion and perfusion-weighted MRI within 24 hours of testing. Exclusion criteria were: acute stroke limited to brainstem and cerebellum; altered level of consciousness; ongoing sedation; inability to provide consent or indicate a family member to provide consent; previous symptomatic stroke; previous neurological or psychiatric disease; known uncorrected hearing loss; known uncorrected visual loss; contraindication for mri or gadolinium; lack of premorbid proficiency in English.

Testing:

Patients were assessed using a battery of lexical tests within 48 hours of stroke. Three tasks of interests were word repetition, reading aloud, and object naming. Stimuli were matched in word frequency, length in phoneme and syllables, and word class. There were 34 words for reading and repetition and 17 pictures and 17 objects for naming. Initial responses were scored and recorded.

Magnetic Resonance Imaging**:**

The patients' scans were analyzed for tissue dysfunction [bright on diffusion weighted imaging (DWI) and dark on absolute diffusion coefficient (ADC) maps) and/or >4 sec delay in time to peak arrival of Gadolinium on perfusion weighted imaging (PWI)] in Brodmann Areas 44, 45, and 47 by the first author, without knowledge of performance on the lexical tests. The author determined whether each patient's infarct and/or area of hypoperfusion covered the area corresponding to the BA using published templates. PWI scans were registered to T2 which have better spatial resolution to identify anatomical landmarks.

Statistical Analysis:

We performed chi square tasks to identify associations between infarct/hypoperfusion to each of the three regions of interest (ROI) (BA 44, 45, and 47) and impairment on each lexical task. We defined impairment on each lexical task as > 10% error the task, based on previous data showing that >10% errors was 2 standard deviations below the mean performance by neurologically normal subjects on these tasks and below the cut-off of any of the normal subjects on any of the three of these tasks (Hillis et al. 1999).

Results

Results are summarized in Table 1. We confirmed our hypothesis that left BA 47 was not associated with acute deficits in reading, naming, and repetition as commonly as left BA 44 and 45. Although BA 47 was found to have an association with object naming and reading aloud tasks, with a chi square of 5.44 and p-value of 0.02, these associations were substantially weaker than the association with either BA 44 or 45 (see Table 1). Area 47 showed a nonsignificant association on the repetition task with a chi square of 3.52 and a p-value of 0.06. In comparison, BA 44 and 45 showed strong associations with repetition (chi squares of 13.79 and 14.65 and p-values of 0.0001 and 0.0001, respectively).

Discussion

Ischemia in BA 47 was associated with impaired repetition, object naming, and reading aloud. Its association, though, was substantially weaker than both BA 44 and 45, the areas classically considered to be "Broca's Area." The results for areas 44 and 45 are consistent with other studies in that they have a strong association with language production. These findings indicate that BA 47 is not necessary for these lexical production tasks acutely but may play a supportive role BA 44 and 45. Together with results from chronic stroke indicating that BA 47 is frequently damaged in patients with chronic aphasia, our results hint that left BA 47 may be an area that is critical for good recovery of oral reading, repetition, and naming. Longitudinal studies from the acute to chronic stage, particularly in patient both with and without damage to left BA 44/45 with and without left BA 47 will be essential to answer this question.

References

Caplan,D., Alpert, N., Waters, G. Olivieri, A. (2000). Activation of Broca's area by syntactic processing under conditions of concurrent articulation. *Human Brain Mapp*, 9: 65-71.

Crinion, J. Personal correspondence, 2009.

Dapretto, M. Bookheimer, SY. (1999). Form and content; dissociating syntax and semantics in sentence comprehension. *Neuron*, 24: 427-32.

Grodzinsky, Y. (2000). The neurology of syntax: language use without Broca's area. *Behavioral Brain Science*, 23: 1-21.

Hillis, A.E., Barker, P., Beauchamp, N., Gordon, B. & Wityk, R. (2000). MR perfusion imaging reveals regions of hypoperfusion associated with aphasia and neglect. *Neurology*, 55: 782-788.

Meneti, L., Petersson KM., Scheeringa R., Hagoort P. (Dec 21 2009). When elephants fly: differential sensitivity of right and left inferior frontal gyri to discourse and world knowledge. *Journal of Cognitive Neuroscience*, 12: 2358-68.

Mohr JP., Pessin MS., Finkelstein S., Funkenstein HH., Duncan GW., Davis KR. (1978). Broca aphasia: Pathologic and clinical. *Neurology*.;28:311-324.

Stowe LA. (2000). Sentence comprehension and the left inferior frontal gyrus: Storage, not computation. *Behavioral and Brain Sciences*, 23:51.

Table 1 Chi Square Values and p-Values for Brodmann Areas 44, 45, and 47 on Language Tasks

		BA 44	BA 45	BA 47
Object Naming	Chi square	19.76	7.54	5.44
	p-value	0.0001	0.006	0.02
Reading Aloud	Chi Square	5.46	4.43	5.44
	p-value	0.02	0.035	0.02
Repetition	Chi square	13.79	14.65	3.52
	p-value	0.0001	0.0001	0.06