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# Neuroanatomical Substrates of Anomia in Patients with Lexical Agraphia

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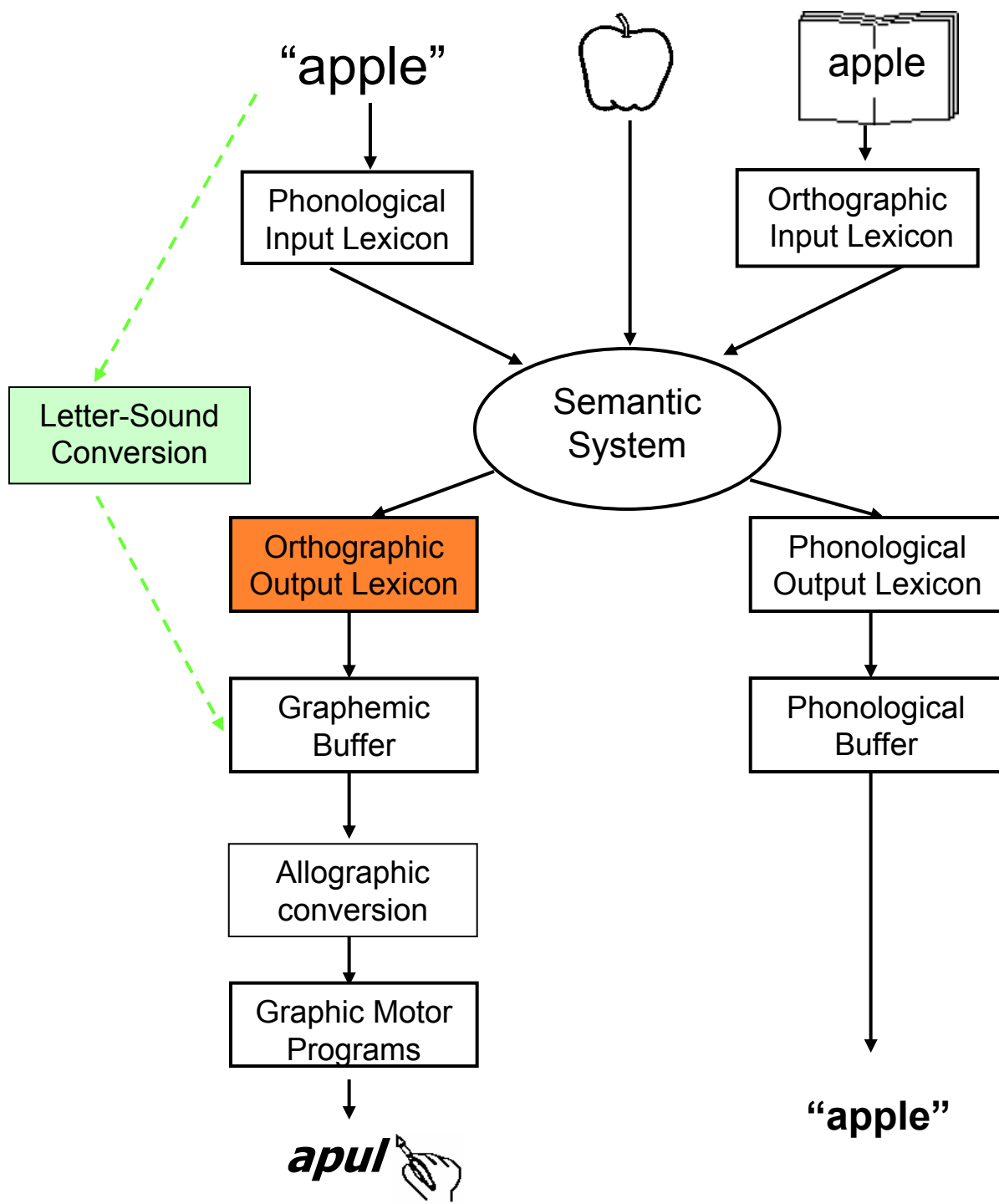
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# Background and Significance

## Behavioral Characteristics of Lexical Agraphia

- In 1981, Beauvois & Dérouesné published a case report of an individual with an acquired writing impairment that reflected damage to spelling knowledge without impairment of phoneme-grapheme conversion. Thus, the patient could not recall the spellings of familiar words, but could produce phonologically plausible spellings.
  - This syndrome has since been documented by others and is referred to as lexical agraphia. It is characterized by relatively preserved spelling of words with conventional sound-to-letter correspondences (e.g., bake) and impaired spelling of words with irregular spellings (e.g., choir). Spelling is accomplished using sound-to-letter conversion, so that errors tend to be phonologically plausible (e.g., quire), and nonwords are often spelled appropriately (e.g.,, flig).
  - Naming impairment is often noted in individuals with lexical agraphia, however, degree of anomia and its relation to lesion location has not been examined.
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## Lexical Agraphia

- Damage to lexical-semantic spelling route (orthographic output lexicon)
- Reliance on phonological spelling route

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# Background & Significance

## Neuroanatomy of Lexical Agraphia and Anomia

- Reports of lesion location in patients with lexical agraphia, with etiologies ranging from closed head injury to the presence of hematoma and angioma, have implicated several areas of the brain; including the “left parieto-occipital” region, and “left temporo-parietal and left occipito-temporal” regions. Recent lesion studies and fMRI research with normal participants have suggested a critical role of the posterior-inferior temporal lobe, specifically Brodmann Areas 37 and 20, relative to the orthographic output lexicon.
  - Whereas lexical retrieval difficulty, or anomia, is observed following damage throughout the left hemisphere, relatively pure anomia has been associated with posterior temporo-occipital regions, including Brodmann Area 37. Anomia of this type reflects failure to retrieve phonological word forms. It has been contrasted with naming impairment that results from degraded semantic knowledge (as observed in semantic dementia), which has been associated with abnormalities in more anterior temporal regions (i.e. Brodmann Areas 20 and 21).
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# Background & Significance

- The co-occurrence of lexical agraphia and anomia is not surprising, given the overlapping neuroanatomical regions. It is not clear, however, whether the extent of temporal lobe damage along the anterior-posterior axis is a determining factor with regard to the presence or degree of anomia.
  - This question was addressed in Japanese patients with “Kanji agraphia”. Sakurai & colleagues (1994) found:
    - Patients with damage restricted to BA 37 evidenced little or no naming impairment
    - Patients with damage extending into the anterior part of the middle temporal gyrus (BA 20/21) demonstrated concomitant anomia
    - Concomitant anomia was attributed to a disruption to the flow of semantic information required to access stored lexical knowledge from BA 37
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# Purpose and Hypothesis

- The purpose of this study was to examine the relationship between degree of anomia and lesion location for English speaking patients with lexical agraphia resulting from left posterior cerebral artery stroke.
  - The hypothesis was that patients with lesions extending into more anterior regions of the posterior-inferior temporal lobe would demonstrate a greater degree of naming impairment.
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# Participant Demographic Information & Performance on the *Western Aphasia Battery*

	<b>TF</b>	<b>EM</b>	<b>FS</b>	<b>MS</b>	<b>CC</b>	<b>RB</b>	<b>RN</b>	<b>MH</b>
<b>Gender</b>	male	male	male	male	male	male	male	male
<b>Age (years)</b>	74	74	80	86	68	61	60	49
<b>Education (years)</b>	16	12	16	16+	10	12+	12	16
<b>Time Post Onset (months)</b>	8	3	8	13	26	40	2	4
<b>Handedness</b>	R	R	R	R	R	R	R	R
<b>WAB Aphasia Quotient</b>	89	91.6	84.8	95	92.4	95.8	98.4	100
<b>WAB Aphasia Type†</b>	Anomic	Anomic	Anomic	N-A	Anomic	N-A	N-A	N-A

† “N-A” indicates a score equated with non-aphasic on the *WAB*

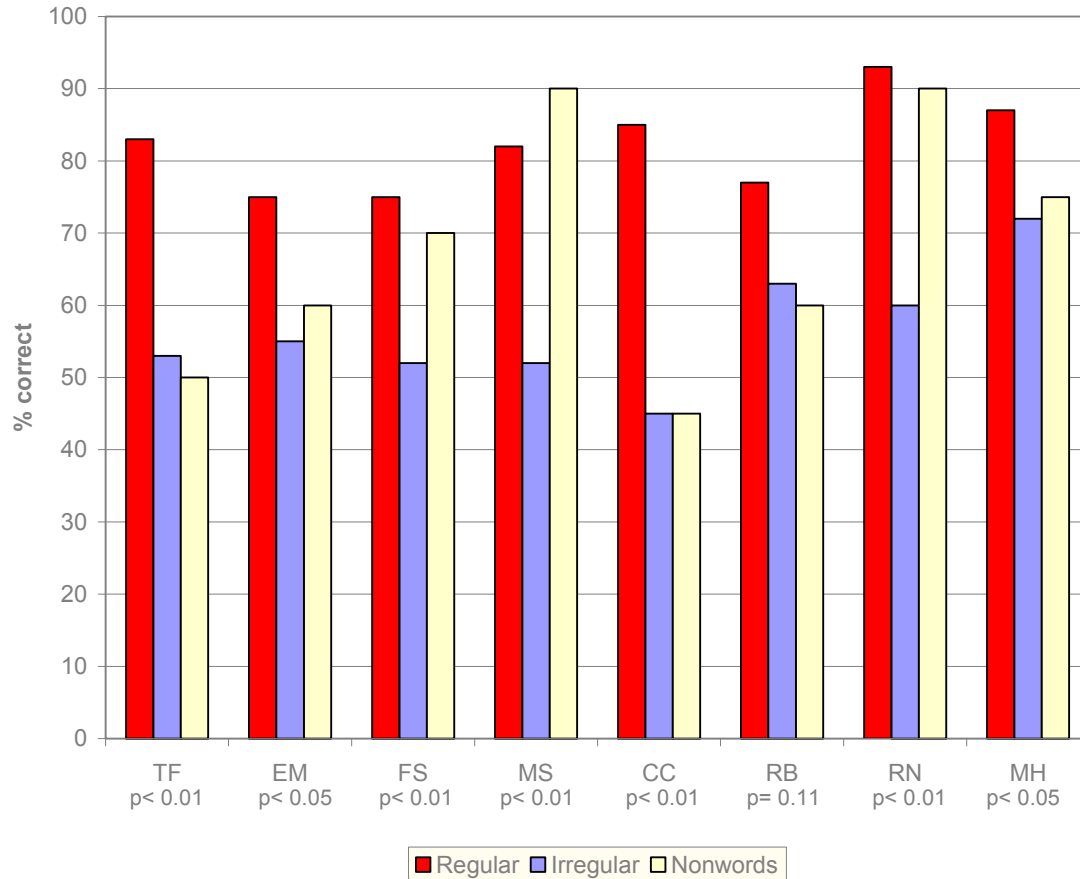
# Participant Performance on Assessment Tasks

Tests	TF	EM	FS	MS	CC	RB	RN	MH
<b>Writing Words to Dictation</b>	82/120*	78/120*	76/120*	80/120*	78/120*	84/120*	92/120*	95/120*
<b>Nonword Writing</b>	10/20*	12/20*	14/20*	18/20*	10/20*	12/20*	18/20*	15/20*
<b><i>Boston Naming Test</i> †</b>	16/60*	16/60*	25/60*	36/60*	37/60*	41/60*	45/60*	60/60
<b><i>Pyramids &amp; Palm Trees</i> † (test of semantics)</b>	47/52*	45/52*	47/52*	51/52	42/52*	48/52*	52/52	49/52

\* Indicates impaired performance

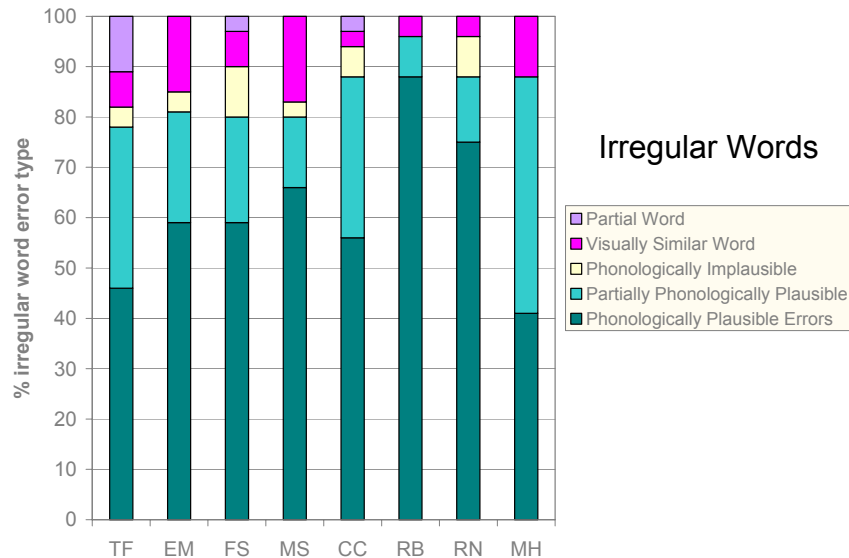
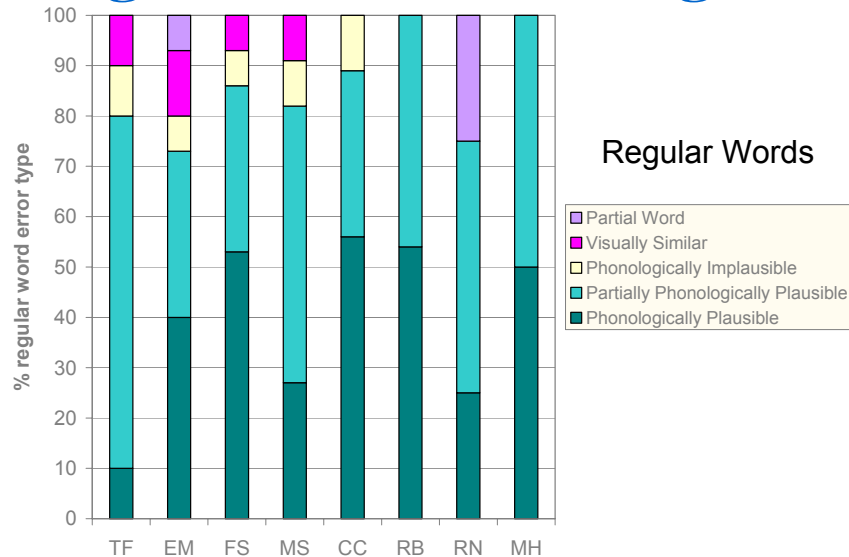
† no correlation existed between results on the *BNT* and *P&PT* ( $r= 0.43$ ,  $p= 0.14$ )

# Single Word Writing to Dictation



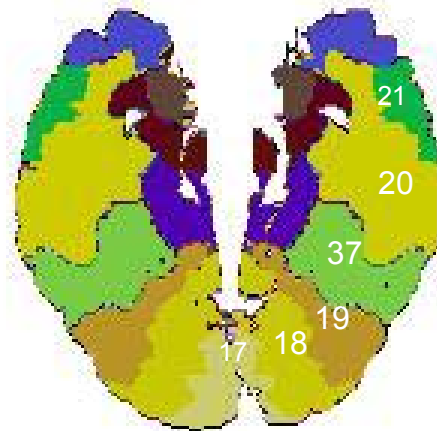
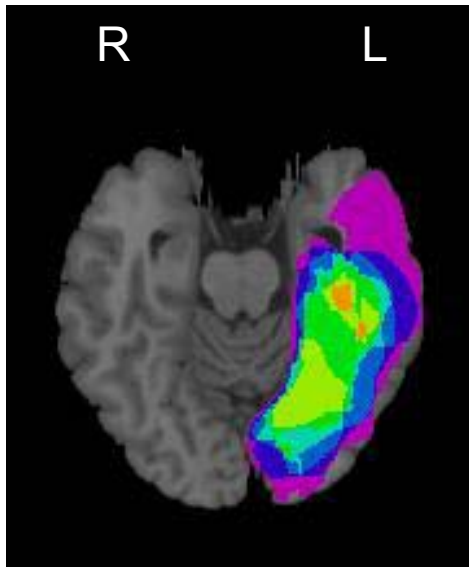
- Consistent with the profile of lexical agraphia, participants demonstrated a regularity effect.
  - Regular word spelling was more accurate than irregular word spelling.
  - Statistically significant for all, except RB
- Nonword spelling was inconsistent.
  - For some participants, it was comparable to regular word spelling.
  - For others, it was comparable to irregular word spelling.

# Single Word Writing Error Types

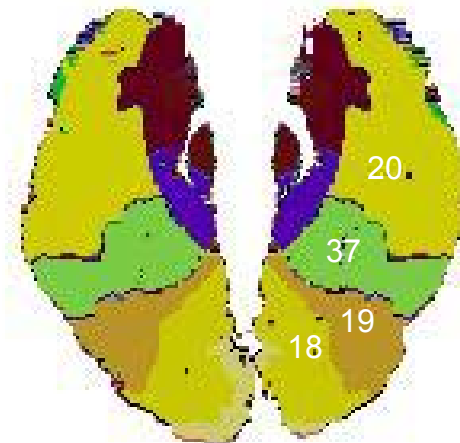
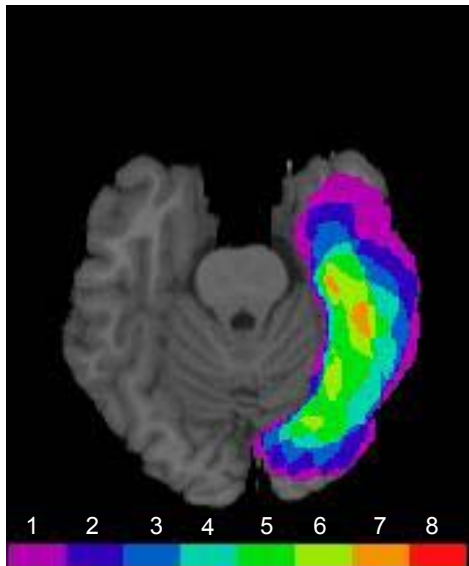


- The majority of spelling errors for both regular and irregular words demonstrated at least partial use of a phonological strategy.
- This observation, coupled with information about nonword spelling, suggests that the use of a phonological spelling strategy for these participants was common, but not fully effective.
- However, the overall profile of writing impairment for all participants remained consistent with lexical agraphia.

# Participant Lesion Maps

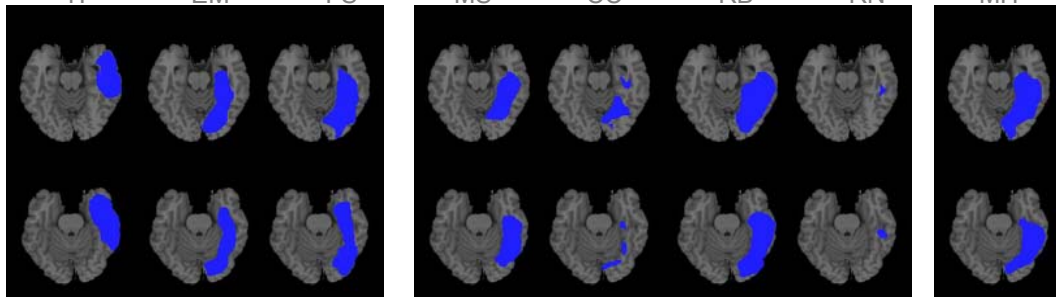
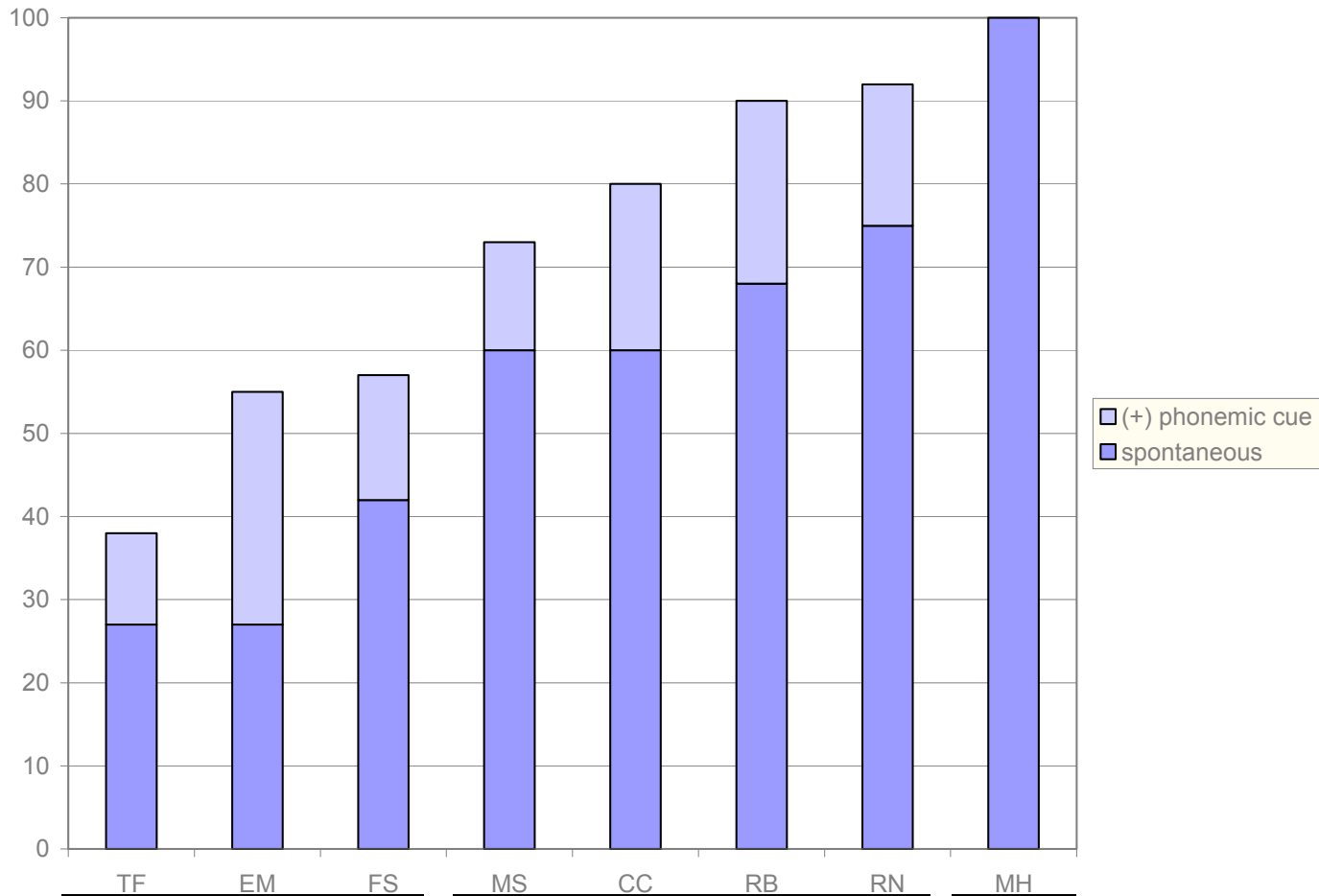


- Lesions were mapped, using MRicro software, on two axial slices that reflected common areas of damage.



- Figure shows regions of lesion overlap for the largest number of participants were Brodmann Areas 20 and 37.

# BNT Results and Participant Lesion Maps



- Results are ordered from most impaired to least impaired naming ability
- Visual analysis comparing site of lesion with degree of anomia suggests a progression in naming impairment with increasingly anterior lesion extension, with the exception of MH, who had unimpaired naming ability despite a sizeable lesion in BA 37 and 20.
- Correlations calculated between BNT score & anterior-most coordinate for each slice provide further evidence for this relationship
  - Superior slice
    - $r = -0.59$ ,  $p = 0.06$
  - Superior slice (w/o MH)
    - $r = -0.77$ ,  $p = 0.02$
  - Inferior slice
    - $r = -0.75$ ,  $p = 0.02$

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# Summary of Results

- All participants had some degree of damage to BA 37 and/or BA 20 and they all demonstrated a pattern of spelling impairment consistent with damage to the lexical spelling route with reliance on phonological strategies, consistent with the writing impairment of lexical agraphia.
  - With the exception of MH, participants with lesions that extended to regions farther anterior in the posterior-inferior temporal lobe demonstrated the greatest degree of naming impairment.
  - This impairment does not appear to have been the result of significant loss of semantic knowledge.
    - Only 3 participants showed mild impairment on the semantic test.
    - All participants often provided semantic information during instances of anomia.
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# Theoretical & Clinical Perspectives

- Our data provide preliminary support for these hypotheses:
    - a relationship exists between anterior lesion extension in the inferior temporal lobe and degree of concomitant anomia in patients with lexical agraphia
    - damage extending into BA 20/21, in the absence of significant loss of semantic knowledge, may result in a disconnection between semantic knowledge and access to phonological word forms.
  - These data demonstrate that performance on standardized aphasia batteries may not reveal naming and spelling impairments of a magnitude that may have a profound effect on occupational goals and personal lifestyle.
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