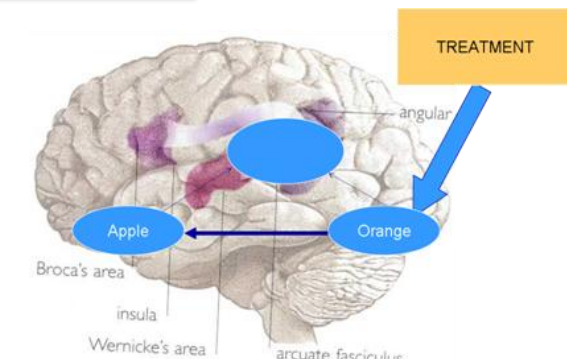# Neural correlates of treatment effects on abstract and concrete words in aphasia: A pilot study

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Background

❖ Behavioral data from both normal and brain-injured subjects suggests that abstract words and concrete words are processed differently (i.e., **concreteness effect**). For example, the Dual Coding Theory (Paivio, 1991) suggests that **abstract** words are encoded into the semantic system with only **verbal** information and **concrete** words are encoded into the semantic system with both **verbal and multi-modal sensory** information

❖ Evidence from recent **neuroimaging** studies suggests the possibility of **dissociable neural correlates** for abstract and concrete word processing (Binder et al., 2009, Sandberg & Kiran, manuscript in preparation)

❖ Patients with **aphasia** exhibit an **exaggerated concreteness effect** behaviorally (Nickels & Howard, 1995; Barry & Gerhand, 2003) and concreteness has been **successfully manipulated in treatment to increase effectiveness** (Kiran, Abbott, & Sandberg, 2009)

❖ Is there a connection between the dissociable neural correlates of abstract and concrete words and the beneficial effect of training abstract words, which are less concrete and therefore more complex?

Participants

❖ Patients with aphasia

  ❖ N=3; 1 m, 2 f; age range: 55-67 (M: 59); R-handed; monolingual English-speaking

  ❖ CVA in LH with subsequent difficulties in word retrieval

Patient	Aphasia Type	Aphasia Severity (WAB AQ)	Boston Naming Test
1	NA	96.7 (very mild)	93.3%
2	Conduction	77.7 (mild to moderate)	86.7%
3	Transcortical Motor	82.2 (mild to moderate)	83.3%

Treatment Protocol

Semantic Feature Analysis (variation of Boyle & Coelho, 1995)

  ❖ Training set of 10 words
  ❖ For each word, participant:
    ❖ Chooses 6 features that belong to the word
    ❖ Answers 15 yes/no questions about the word
    ❖ Identifies whether word is abstract or concrete
    ❖ Generates a synonym for the word

**P1:** 10 weeks of treatment; *abstract* words in context of *hospital*
P2: 4 weeks of treatment; *abstract* words in context of *hospital*
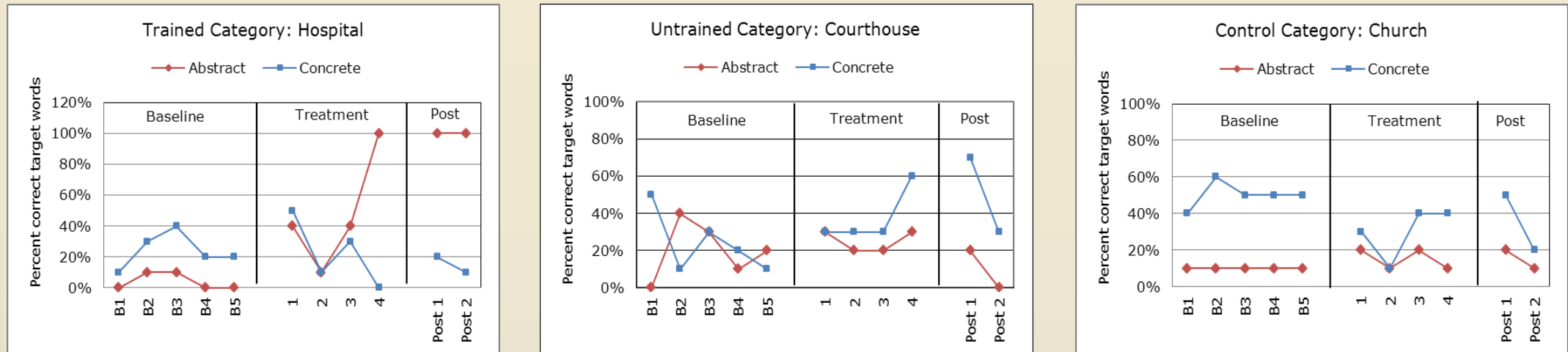**P3:** 10 weeks of treatment; *abstract* words in context of *courthouse*
  ❖ Untrained contexts used as controls
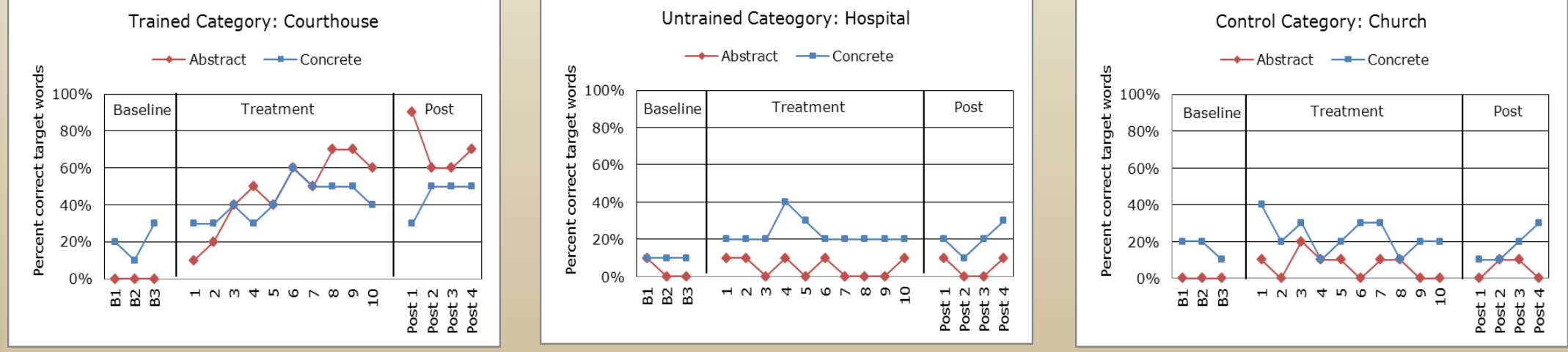
Treatment Results

P1: Improved on trained abstract items; generalized to concrete items in same context (also slightly improved on abstract items in untrained category and concrete items in control category)
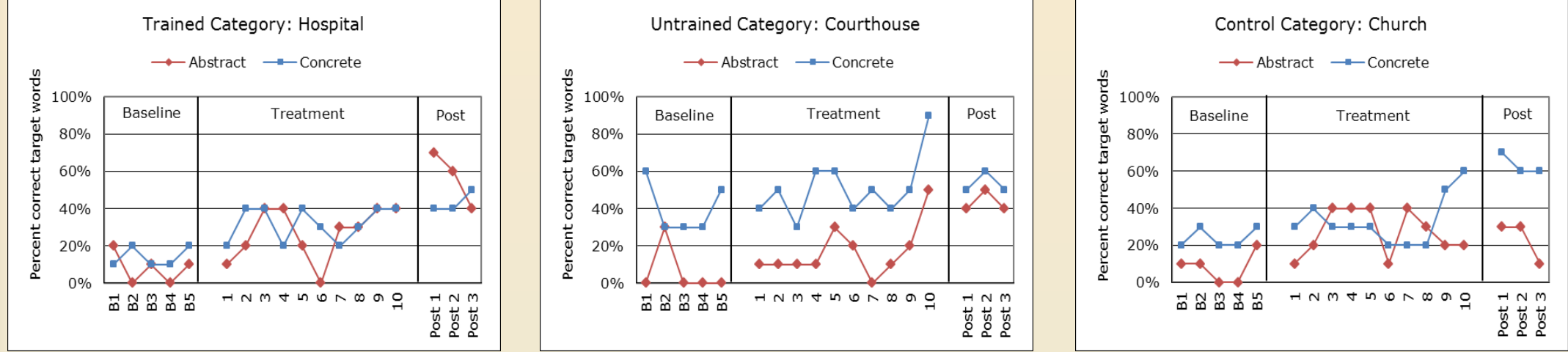

P2: Improved on trained abstract items only

P3: Improved on trained abstract items; generalized to concrete items in same context


fMRI Paradigm

  ❖ Event-related design
    ❖ 3T Phillips; T1 structural: TR=26ms, 128 1.3mm slices; BOLD: TR=2Kms, 31 3mm slices
  ❖ Patients scanned both before and after treatment, data analyzed with SPM8

Tasks

❖ Word Judgment
  ❖ 50 abstract / 50 concrete words
    25 vowel / 25 consonant strings
  ❖ Is the word abstract or concrete?
    Is the letter string consonants or vowels?
❖ Synonym Judgment
  ❖ 50 abstract / 50 concrete word pairs
    100 nonword pairs
  ❖ Are these words similar in meaning?
    Are these nonwords the same?
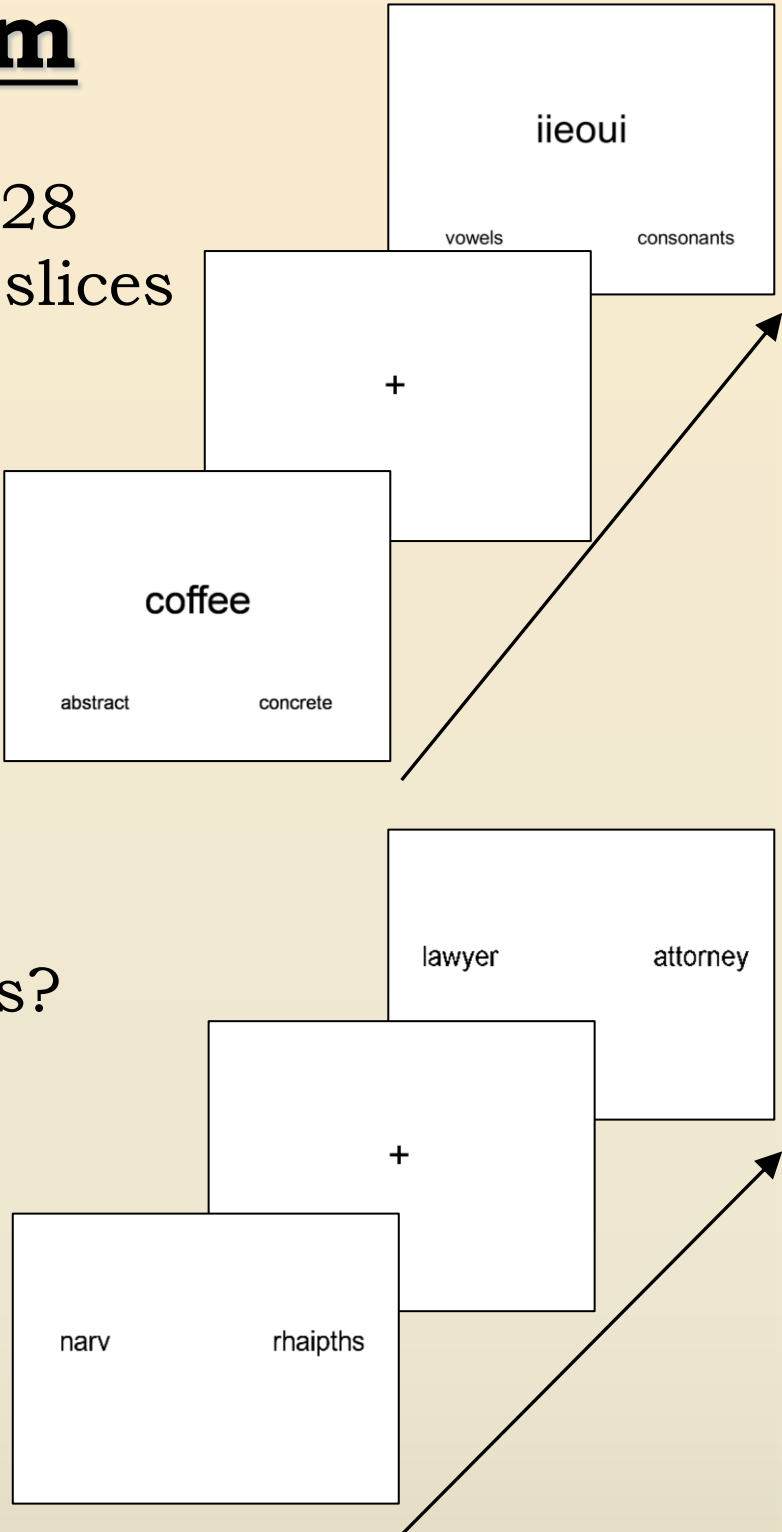

|	Word Judgment Task	Synonym Judgment Task
Response type	button press	button press
Pseudo-randomized ISI (fixation cross)	2/3/4 sec	2/3/4 sec
Stimulus duration per run	50 stimuli x 4 sec = 200 sec	50 stimuli x 4 sec = 200 sec
runs, items per run	3 runs, 50 items per run	4 runs, 50 items per run

fMRI Results

Legend: Red = activation during abstract word processing, Blue = activation during concrete word processing, Purple = overlap in activation; Left is left, right is right.
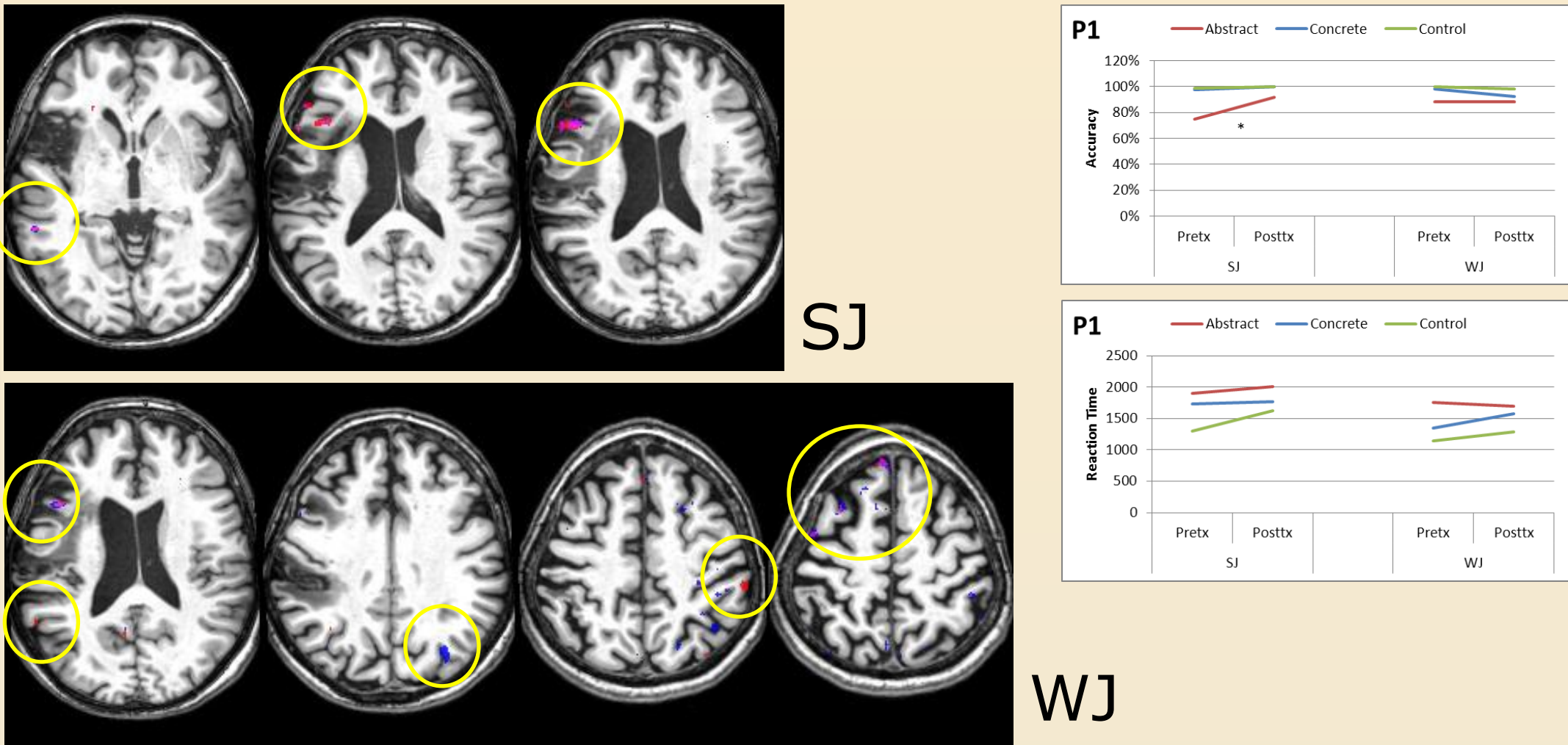
P1: Showed increased activation from pre to post-treatment with overlap between abstract and concrete words. Note that more perilesional activation occurred with abstract words and accuracy for abstract words improved during the synonym judgment (SJ) task.
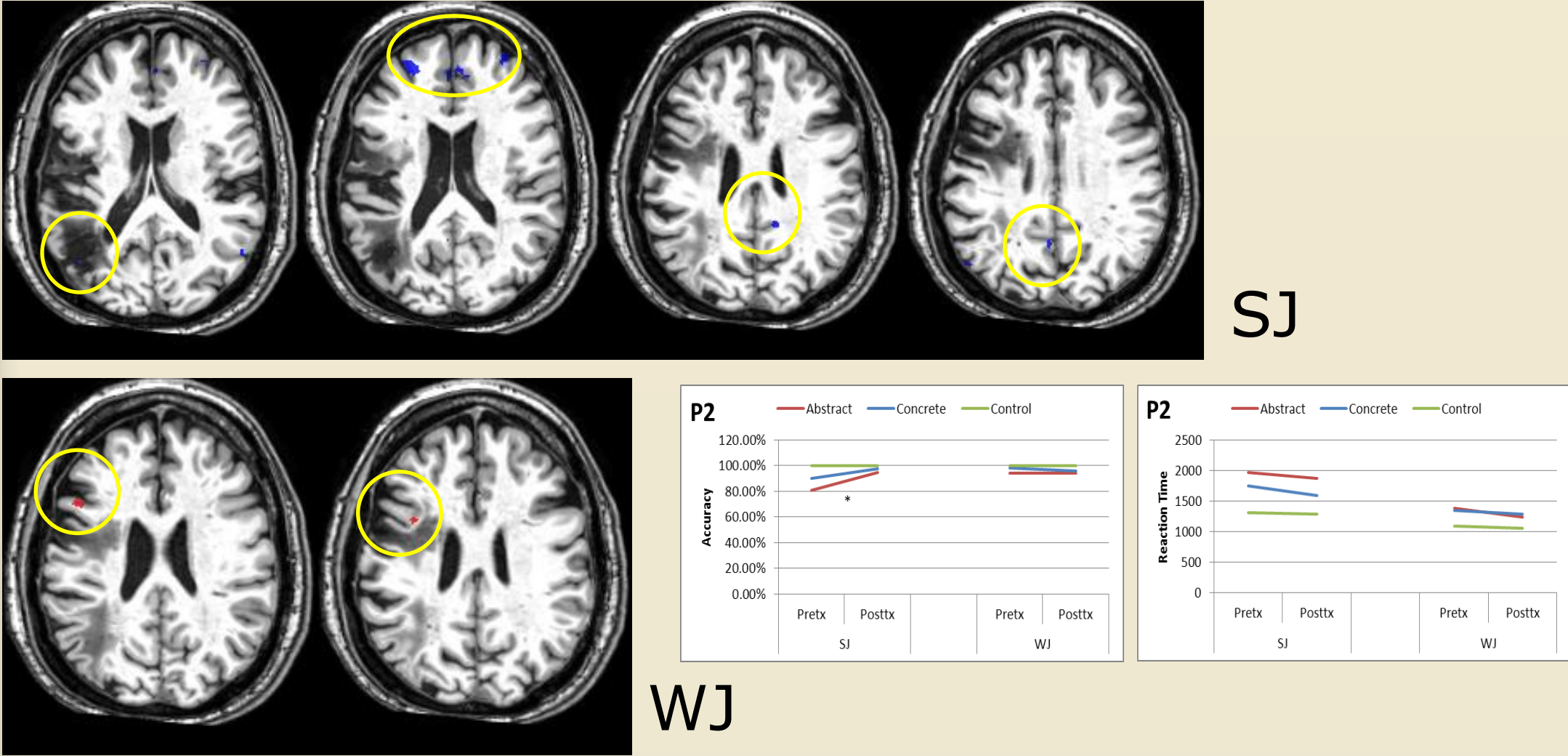
P2: Like P1, showed increased activation post-treatment, but only for abstract words during the SJ task and concrete words during word judgment (WJ). Note that increased activation for abstract words was accompanied by increased accuracy during the SJ task.
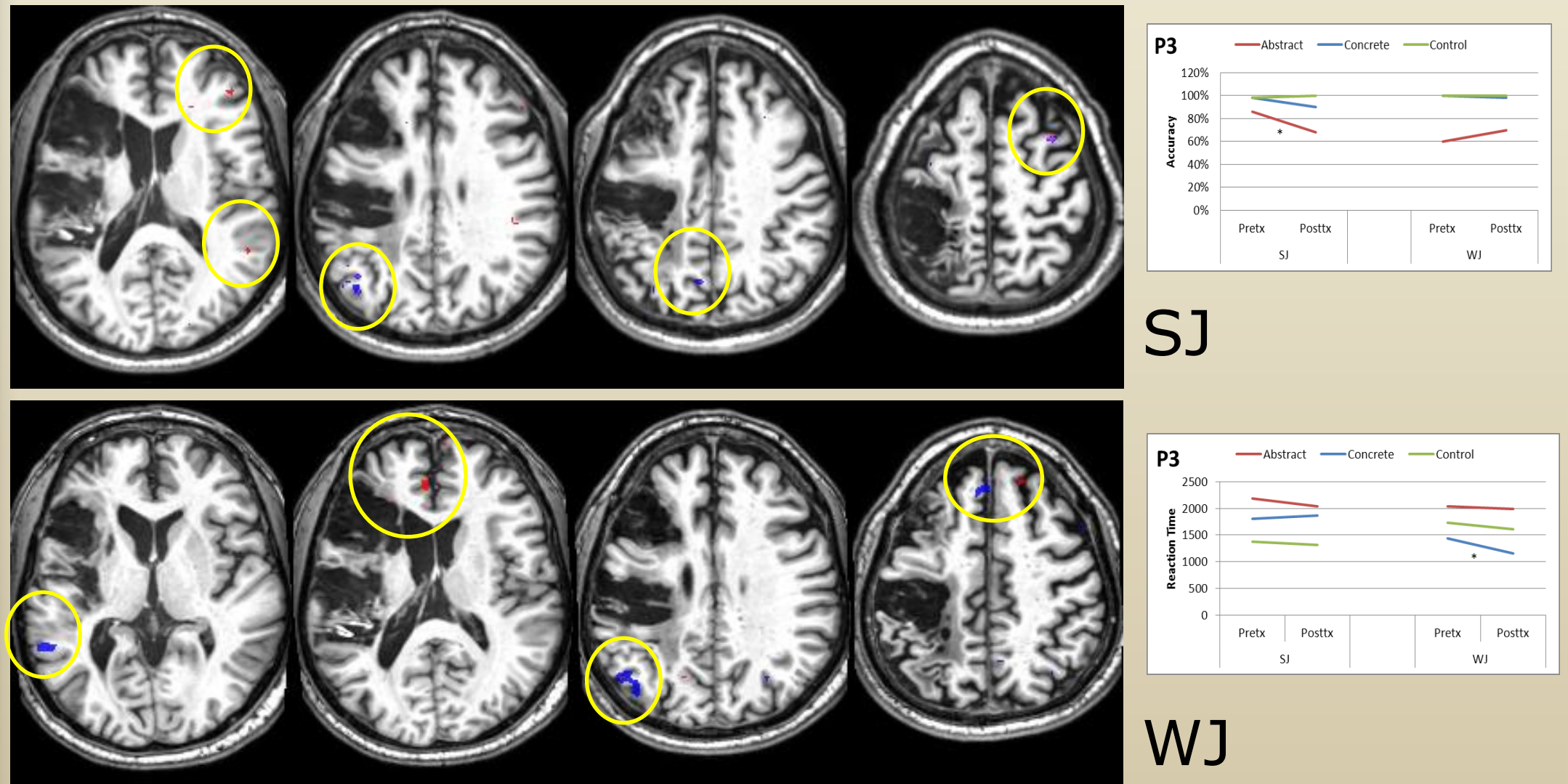
P3: Like P1 and P2, showed increased activation post-treatment. Furthermore, he showed increases for both abstract and concrete words in distinct regions. Note this coincides with treatment outcomes.

Discussion

❖ All three patients improved on the trained abstract words; two patients also generalized to concrete words in the same context.

❖ All three patients showed increased activation in spared left hemisphere language areas after treatment. This supports the notion that better language recovery in chronic aphasia is associated with transfer of language function from compensation of the right hemisphere to spared language areas of the left hemisphere (Saur et al., 2006)

❖ In both P1 and P2, much of left IFG was spared by the lesion and in P1, much of the left temporal lobe was also spared; however, P3's lesion was quite large yet he showed similar results as the other two patients.

❖ Abstract and concrete nouns tended to overlap in activation both before and after treatment, which is consistent with age-matched controls (Sandberg & Kiran, unpublished data).

❖ Notably, however, the trained structure (abstract words) showed more increased activation than concrete words. This matches the behavioral results seen both during treatment and while scanning.

Conclusion

❖ These tentative results suggest:

  ❖ Training abstract words increases activation in areas thought to process abstract words.

  ❖ Generalization from abstract to concrete words during treatment may coincide with increased neural activation for concrete words from pre- to post-treatment.

❖ It is important to note that these patients were more highly functioning than the average aphasic patient with highly accurate responses on the fMRI task even before treatment.

❖ Future research should focus on a larger sample, with a wider severity range.

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