

## **Introduction**

Acquired dyslexia and dysgraphia present unique challenges to both patients and clinicians. Rapid recovery of reading and writing skills following brain injury is often critical for a return to functional independence. However, much remains unknown regarding etiology-driven remediation strategies for adults with aphasia. One reading treatment for acquired phonological dyslexia that has shown promise is an approach by Friedman and Lott (2002) that uses bigraph-phoneme correspondences to improve sound-blending ability. Typically, improvement of sound blending ability has been approached by training single phoneme-grapheme correspondences, but results with this approach are mixed because segmenting words into single grapheme-phoneme correspondences distorts the pronunciation of the word. Segmenting words into bigraph-phoneme correspondences, however, approximates the pronunciation of the word more precisely.

Here we report a replication and extension of Friedman and Lott's (2002) sound blending treatment applied to a single participant with acquired phonological dyslexia who progressed from an inability to read one-syllable non-words to reading and writing of phrase length material.

## **Method**

### *Participant*

LP, a 45 year old, right-handed female, experienced an acute left CVA in May, 2000, involving the left frontal and parietal lobes and insular cortex. Following discharge from a rehabilitation hospital, LP completed outpatient speech therapy for 8 months. At the time of her stroke, she was employed as a sports writer with a Philadelphia newspaper. LP remains employed by the same newspaper, although her duties have been modified to accommodate her aphasia and restricted reading and writing abilities.

LP enrolled in this study 2.8 years post onset, at which time she presented with chronic conduction aphasia. Baseline measures indicated intact semantic abilities and relatively poor phonological abilities (Table 1), as well as phonological dyslexia and dysgraphia, the latter being more severe.

### *Experimental Design*

A single subject, single baseline design, alternating between reading and writing was implemented for three different treatments between 2003 and 2005.

### *Treatment/Procedure*

Initially, treatment focused on improving LP's awareness of grapheme-phoneme correspondences and sound blending abilities for one-syllable nonwords. The successful completion of this protocol was followed by two treatments to extend these abilities to reading and writing two-syllable words and phrase length material. For all three treatments, a baseline was established before training began, all trained and control items were probed at the beginning of each session to track progress, and items were trained until a criterion of 90% accuracy was reached over two consecutive sessions. Also, for each treatment protocol, training of reading preceded training of writing. Writing treatment always involved the same words that were trained in reading, but with a new baseline measure.

**Treatment 1: Rehabilitation of sound blending abilities using bigraph-phoneme correspondences: A replication and extension of Friedman and Lott (2002).** One-syllable nonwords were used to discourage LP's tendency to rely on a lexical reading strategy. Stimuli in the first two training sets had a CVC structure and in a replication, a CCVC and CVCC structure. Thirty nonwords were trained while 15 nonwords and 15 real words served as control items. Training involved the following steps:

Reading:

1. Flash cards with a CV – VC representation of a nonword (e.g. BE – EK) were presented for reading.
2. Representation of the whole nonword was presented for reading (e.g. BEK).

Writing:

1. Biphones of the nonword (e.g. BE – EK) were presented orally in succession for LP to write.
2. The spoken nonword (e.g. BEK) was presented for LP to write.

Practice for each trained item continued until LP read or wrote the nonword correctly.

**Treatment 2: Extension of treatment protocol 1 to two syllable words.** This treatment introduced two-syllable words with CVCVC, CVVCVC, and CVCCVC structures. A baseline was established using eighty words (40 trained, 40 control items) that LP was unable to read or write consistently. Training involved the following steps:

Reading:

1. Review of bigraph-phoneme correspondences for vowels and clusters, and strategies for producing consonants that were consistently difficult for LP.
2. A flash card was presented with 3 versions of the same word (1) the word divided into 3 bigraphs (e.g. CA – ME – EL) (2) the word divided into 2 bigraphs (e.g. CA – MEL) and (3) the word as a whole (e.g. CAMEL).

Writing:

1. Biphones of the trained words were presented orally (e.g. CA – ME – EL, CA - MEL) for LP to write. This was followed by the spoken word (e.g. "camel") for LP to write.

Practice for each trained item continued until LP felt confident with the word.

**Treatment 3: Extension of treatment protocol 1 to noun-verb/verb-noun phrases and noun-verb plus prepositional phrases.** New two-syllable nouns were paired with verbs to make 48 noun-verb phrases (e.g. "the model struts") and verb-noun phrases (e.g. "prepare the lesson"). These were divided into trained and control items.

After reading and writing criteria were reached, the phrases were paired with prepositional phrases (e.g. "for the students") to make new, more difficult phrases (e.g. "prepare the lesson for the students"). Training for both the noun-verb and verb-noun phrases and the noun-verb prepositional phrases involved the following steps:

1. Reading and writing words syllable by syllable.
2. Practice reading phrases fluently.

3. Practice on a particular word or phrase continued until LP felt confident with her performance.

## **Results**

Treatment 1: For reading, LP reached criterion quickly, within 8-9 sessions, and sometimes reached criterion during baseline before training was initiated. Writing was always more difficult than reading, and in an early session, LP did not reach criterion after 14 treatment sessions. Following this however, she reached criterion for other writing training sets within 5-7 sessions. See examples for reading and writing treatments in Figures 1a and 1b.

Treatment 2: Gains were made after just six treatment sessions in both reading and writing (Figures 2a-2b).

Treatment 3: LP reached criterion within an average of 3-5 treatment sessions (Figures 3a-4b).

### *Maintenance and Generalization*

LP maintained gains after treatment and improved on the PALPA and the Dolch Word List (Tables 2 & 3). Follow-up testing of reading two syllable words demonstrated scores above her baseline at the end of Treatment 2. Follow up testing is currently being administered for Treatments 2 and 3.

Generalization was not explored in Treatment 2 and the initial sets of Treatment 3 because LP was easily discouraged by her failures. We felt it important to have words and phrases in the control sets that would give her success. Nonetheless, LP's accuracy with control items did improve in the writing set of Treatment 2 from .75 to .85. In Treatment 3, reading noun-verb and verb-noun phrases improved from .78 to 1.00 and in reading noun-verb plus prepositional phrases from .74 to .91.

## **Discussion**

LP was a quick learner. Her accuracy improved through exposure and generalization. Before treatment, LP had difficulty with grapheme-phoneme conversion and tended to use a lexical, whole word approach to reading. Training her to read nonwords enabled her to use the grapheme-phoneme conversion route to read. This success prepared LP for training to read and write two-syllable words and eventually phrases and short sentences. The success evidenced here illustrates the usefulness of this approach, even five years post onset, for reading and writing rehabilitation. It supports the protocol outlined by Friedman and Lott (2002) for improving reading and writing skills in phonological dyslexia.

## References

Dolch, E.W. (1948). *Problems in Reading*. Garrard Press.

Friedman, R. B., & Lott, S.N. (2002). Successful blending in a phonological reading treatment for deep alexia. *Aphasiology*, *16*, 355-372.

Kay, J., Lesser, R. & Coltheart, M. (1992) PALPA. *Psycholinguistic Assessments of Language Processing in Aphasia*. Hove, UK: Lawrence Erlbaum Associates Ltd.

**Table 1.** Background measures of language processing

|   | <u>Raw Score</u> | <u>Percentage</u> |
|---|------------------|-------------------|
| Philadelphia Naming Test  | 96/175           | .55               |
| Boston Naming Test  | 23/60            | .38               |
| Lexical Comprehension   | 44/44            | 1.00              |
| Peabody Picture Vocabulary Test – Form L                                      |                  |                   |
| Raw   | 144              |                   |
| Standard Score  | 85               |                   |
| Synonymy Judgments Noun/Verb  | 29/30            | .97               |
| Synonymy Judgments Concrete/Abstract  | 44/48            | .92               |
| Pyramids and Palm Trees Test  |                  |                   |
| Picture   | 49/52            | .94               |
| Written   | 50/52            | .96               |
| Auditory Lexical Decision   |                  |                   |
| Word  | 171/180          | .95               |
| Nonword   | 171/180          | .95               |
| Phoneme Discrimination – minimal pair judgments with no interval              |                  |                   |
| Word  | 79/80            | .99               |
| Nonword   | 79/80            | .99               |
| Phoneme Discrimination – minimal pair judgments with 5 second filled interval |                  |                   |
| Word  | 77/80            | .96               |
| Nonword   | 71/80            | .89               |
| Rhyme Judgement   |                  |                   |
| Word Pairs  | 53/64            | .83               |
| Nonword Pairs   | 58/64            | .91               |
| Philadelphia Repetition Test  | 127/175          | .73               |
| Repetition – One Word   | 51/60            | .85               |
| Repetition – One Pseudoword   | 16/60            | .27               |

**Table 2:** Treatment 1: PALPA - selected measures of reading and writing pre-treatment and post-treatment.

|  | <u>Pre-Treatment (11/2002)</u> |      | <u>Post-Treatment (11/2003)</u> |      |
|--|--------------------------------|------|---------------------------------|------|
| <b>PALPA 22: Letter Naming &amp; Sounding</b>  |                                |      |                                 |      |
| See Letter/Name Sound  |                                |      |                                 |      |
| Upper case   | .85                            |      | .96                             |      |
| Lower case   |                                |      |                                 |      |
| See Letter/Name Letter   | .88                            |      | .92                             |      |
| Upper case   | .96                            |      | 1.00                            |      |
| Lower case   | 1.00                           |      | 1.00                            |      |
| <b>PALPA 22: Adapted to Writing</b>  |                                |      |                                 |      |
| Hear Sound/ Name Sound   | .85                            |      | .92                             |      |
| Hear Letter Name/Write letter  | N/A                            |      | 1.00                            |      |
| <b>PALPA 23: Spoken Letter-Written Letter Matching</b>                                   |                                |      |                                 |      |
|  | .73                            |      | .88                             |      |
| <b>PALPA 30: Syllable Length Reading</b>   |                                |      |                                 |      |
|  | Write                          | Read | Write                           | Read |
| 1 Syllable   | .88                            | 1.00 | 1.00                            | 1.00 |
| 2 Syllable   | .63                            | .50  | .88                             | .88  |
| 3 Syllable   | .75                            | .38  | .38                             | .75  |
| <b>PALPA 31: Imageability and Frequency (n = 40 for each Imageability and Frequency)</b> |                                |      |                                 |      |
|  | Write                          | Read | Write                           | Read |
| High Imageability  | .75                            | .78  | .78                             | .93  |
| Low Imageability   | .38                            | .33  | .63                             | .55  |
| High Frequency   | .45                            | .48  | .83                             | .75  |
| Low Frequency  | .53                            | .63  | .58                             | .73  |
| <b>PALPA 32: Grammatical Class Reading</b>   |                                |      |                                 |      |
|  | Write                          | Read | Write                           | Read |
| Nouns  | .65                            | .50  | .55                             | .65  |
| Adjectives   | .65                            | .75  | .70                             | .80  |
| Verbs  | .65                            | .65  | .68                             | .85  |
| Functors   | .50                            | .50  | .60                             | .60  |

**Table 3:** Treatment 1: Performance on the Dolch Reading List before and after treatment.

| <b>Pre-Treatment (11/2002)</b> |     |         |     | <b>Post-Treatment (11/2003)</b> |     |         |     |
|--------------------------------|-----|---------|-----|---------------------------------|-----|---------|-----|
| Write                          |     | Read    |     | Write                           |     | Read    |     |
| 173/220                        | .79 | 204/220 | .93 | 203/220                         | .92 | 215/220 | .98 |

Figure 1a.

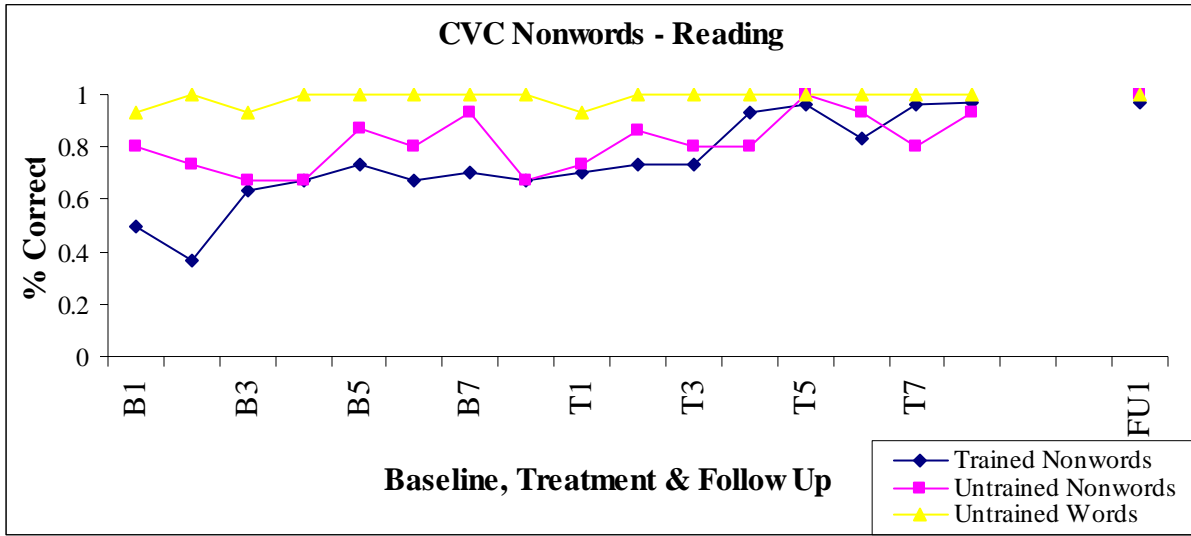


Figure 1b.

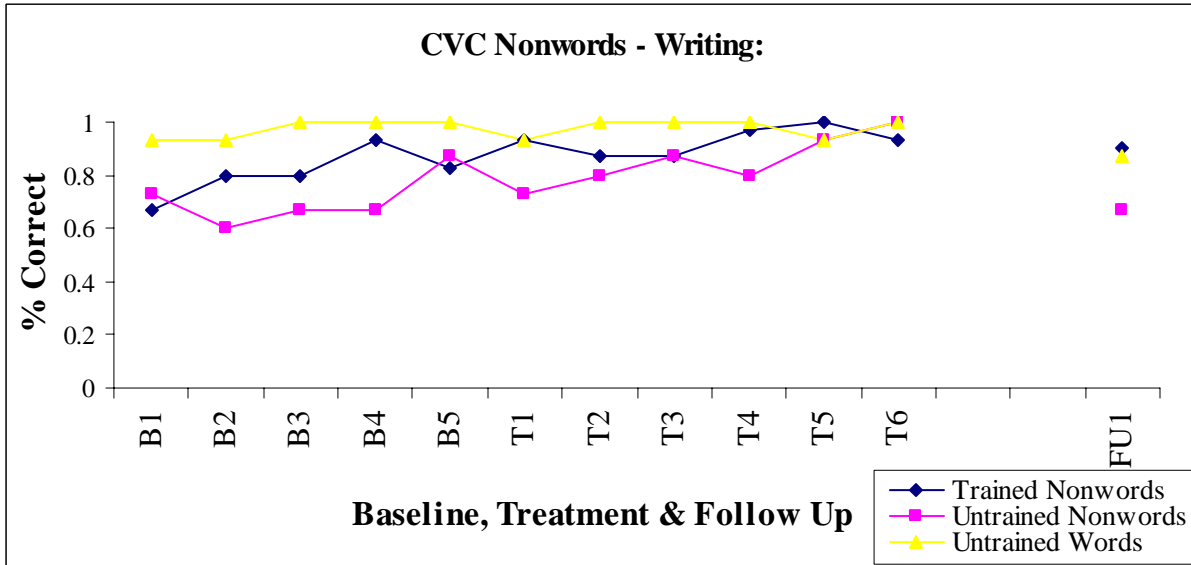




Figure 2a.

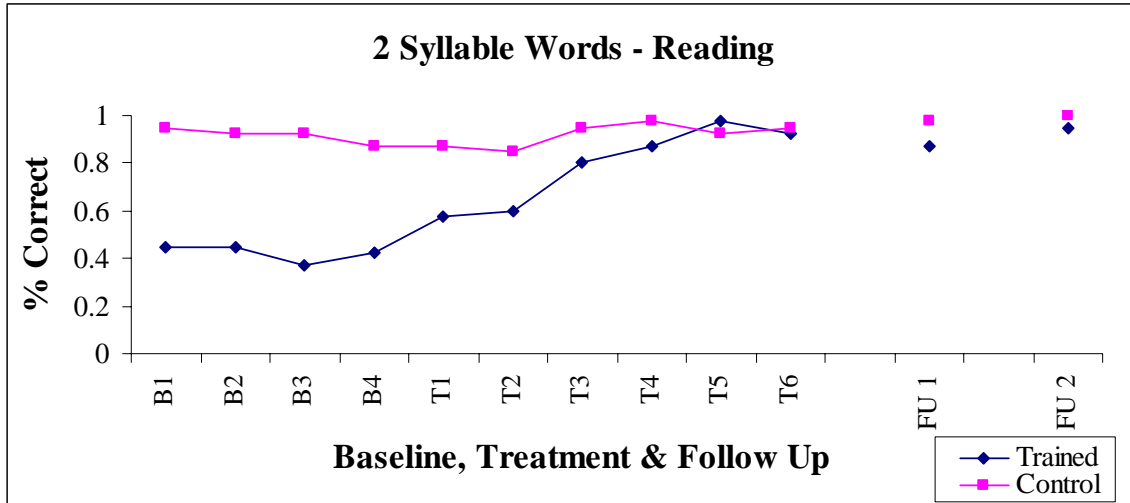


Figure 2b.

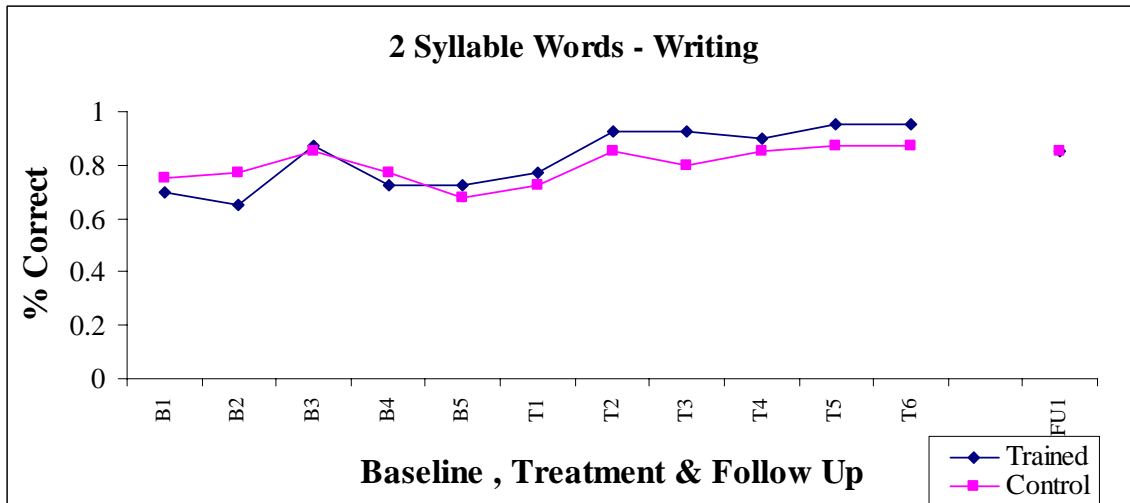


Figure 3a.

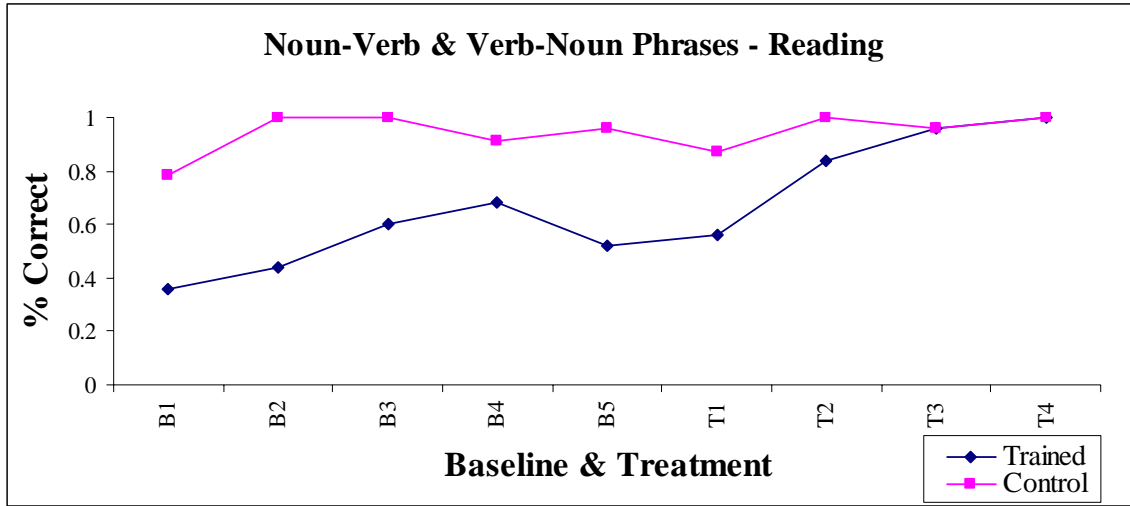


Figure 3b.

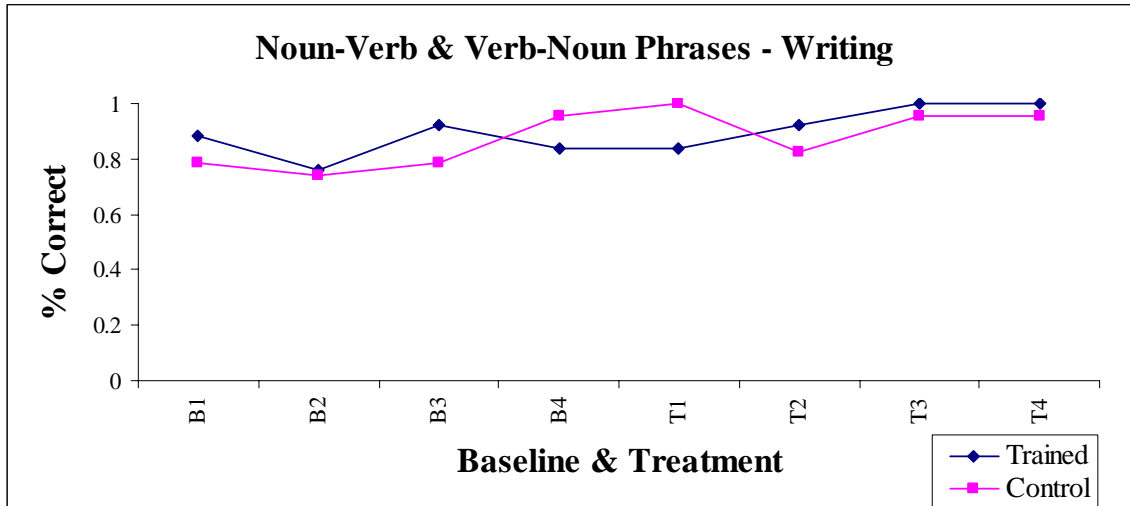


Figure 4a.

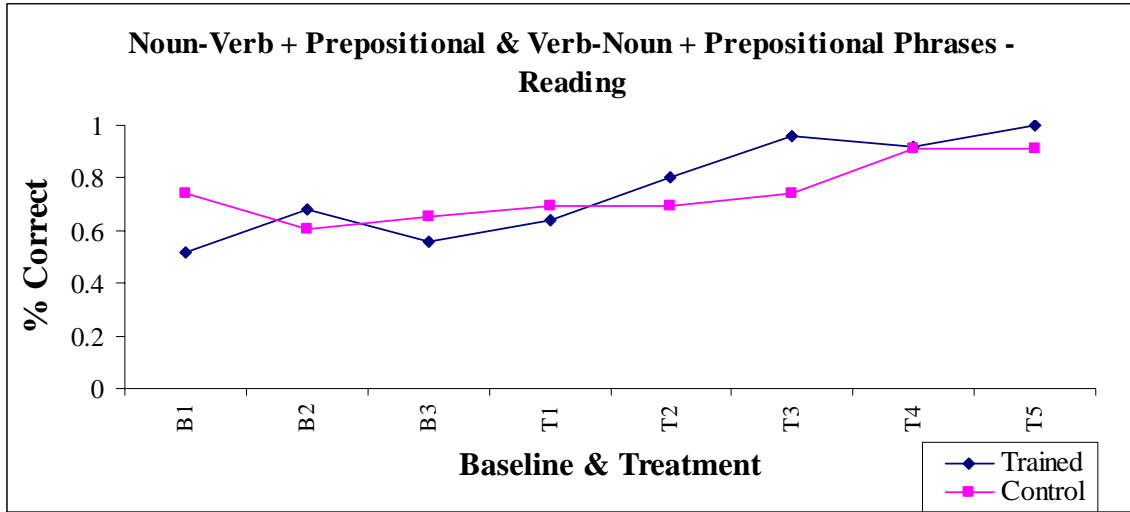


Figure 4b.

