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Concurrent treatment for reading and spelling in aphasia

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Background: Behavioural treatments for impairments of written language have had positive therapeutic effects in patients with alexia and agraphia. However, few researchers have documented the effect of concurrent administration of treatments for reading and writing. Combined treatment has the potential to be an efficient means of rehabilitation for individuals with both reading and spelling impairments.
Aims: The present study was designed to examine the therapeutic value of a concurrent treatment for reading and spelling. The goals of treatment were to increase reading accuracy and rate for text and to improve spelling accuracy for single words.
Methods & Procedures: An individual with chronic aphasia, alexia, and agraphia participated in the treatment, which consisted of a combination of Oral Reading Treatment (ORT) and Copy and Recall Treatment (CART) that was conducted for 10 weeks. Repeated probes at the beginning of each session were used to determine progress and maintenance of treatment gains. Additional language assessments were administered before and after treatment.
Outcomes & Results: Large treatment effects were obtained for reading accuracy of personally relevant scripts and spelling of targeted words, and gains were maintained on follow-up probes. Reading rate for practiced text also improved, but did not generalise when reading new text. Pre- and post-treatment measures indicated significant improvement in reading and spelling of functors not specifically targeted in treatment, and increased grammatical complexity of spoken language. In addition, oral language performance as measured by the *Western Aphasia Battery* (*WAB*) showed clinically significant improvement.
Conclusions: Concurrent reading and spelling treatment was successful in this patient with moderate aphasia. It appears to be an efficient way to effect change in written and spoken language in individuals with aphasia.

Individuals with aphasia due to left perisylvian damage typically experience concomitant impairments of spoken and written language (Benson & Ardila, 1996; Goodglass, 1993). The severity of residual impairments varies in accordance with lesion location and extent, but it is not uncommon for reading to be better preserved than writing, just as auditory comprehension abilities are often stronger than speech production. We present such a profile here—a man with chronic aphasia and relatively preserved (or recovered) single-word reading, and severely limited ability to write single words. At a functional level, this individual wanted to improve reading at the text level, and also to improve single-word spelling. We failed to identify any treatment approaches in the literature that concurrently address such discrepant reading and spelling abilities; however, a number of treatment

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protocols are directed towards either reading or writing skills in individuals with aphasia (see Beeson & Hillis, 2001, for review).

Treatment to improve reading at the text level was examined by Cherney (1995; Cherney, Merbitz, & Grip, 1986) using an approach called Oral Reading for Language in Aphasia (ORLA). This treatment involves clinician-guided oral reading of text-level passages in individuals with impaired reading and spoken language. Her findings with 10 participants showed a therapeutic effect of this approach for increasing reading accuracy and comprehension, as well as significant gains in overall language performance, as measured by the *Boston Diagnostic Aphasia Examination* (*BDAE*; Goodglass & Kaplan, 1972). ORLA bears similarity to another treatment for text reading referred to as Multiple Oral Re-reading (MOR), an approach that was initially shown to be effective for increasing reading rate in individuals with pure alexia (Beeson, 1998; Moyer, 1979; Tuomainen & Laine, 1991). When MOR was implemented with two individuals with mild residual aphasia and persistent alexia, their overall reading rate improved, with a particular benefit for functors as indicated by significantly reduced reading reaction time (Beeson & Insalaco, 1998). Similar to Cherney et al. (1986), both individuals showed clinically significant improvement in overall language performance following oral reading treatment, measured with the *Western Aphasia Battery* (*WAB*; Kertesz, 1982). Together, the findings from these two oral reading treatments suggest the potential for such approaches to positively influence underlying language abilities, as well as oral reading abilities.

With regard to treatments for single word spelling in individuals with aphasia, both lexical and phonological approaches have been examined. Lexical approaches include retraining specific orthographic representations for target words and often rely on repeated copying and recall of target words (Beeson, 1999; Hillis Trupe, 1986; Schwartz, Nemeroff, & Reiss, 1974). Phonological treatments for spelling focus on retraining phonological awareness or specific sound-to-letter correspondences so that spellings may be assembled (Conway et al.; 1998; Hillis & Caramazza, 1994; Weekes & Coltheart, 1996), or emphasise the use of phonological information to support a problem-solving approach to spelling (Beeson, Rewega, Rapcsak, & Vail, 2000). Whereas phonological treatments offer the greatest potential for generalised improvement in spelling, lexical treatments are likely to result in item-specific improvement. However, lexical treatments may be the best approach when phonological abilities appear too weak for remediation, and have been shown to have strong therapeutic value when used with individuals with severe language impairment (Beeson, Rising, & Volk, 2003).

The present study was implemented to examine the therapeutic effects of combining reading and spelling treatments into a coordinated regimen. Although preliminary evidence exists to support text-level reading treatment and single-word spelling treatment, we considered this to be a Phase 1 treatment outcome study, as described by Robey and Schultz (1998), to discern the potential benefits of a concurrent treatment approach. We adapted Cherney's Oral Reading for Language in Aphasia (ORLA) to provide a hierarchy to facilitate accurate oral reading of text, an approach we refer to as Oral Reading Treatment (ORT). Personally relevant scripts were created and served as the text for treatment. The use of scripts was motivated by the work of other researchers who have documented the value of training scripted information to enhance spoken conversational interactions (e.g., Holland & Hinckley, 2002; Worrall & Yiu, 2000; Youmans, Holland, Muñoz, & Bourgeois, this issue). The reading treatment was complemented by Copy and Recall Treatment (CART; Beeson et al., 2003), a lexical approach to retrain spelling of targeted words. Thus, the treatment programme incorporated both ORT and CART to

address impairments in reading and spelling simultaneously, with the goal of increasing reading accuracy and rate for connected text, and spelling accuracy for single words. In addition, we examined the influence of this treatment on spoken language performance.

METHOD

Participant

BB was a right-handed, 58-year-old, English-speaking man with 12 years of education. Two and a half years prior to this study, he experienced a left hemisphere stroke following carotid endarterectomy. An MRI head scan revealed a large lesion in the distribution of the left middle cerebral artery, affecting the left frontotemporoparietal region (see Figure 1). At 4 months post-stroke, BB had a language profile consistent with Broca's aphasia, with an aphasia quotient of 64.4 on the *WAB*. BB received aphasia treatment over the course of the following year, primarily directed towards the improvement of spoken language. He showed improved grammatical construction and increased utterance length, so that at 16 months post-onset, his *WAB* aphasia quotient was 79.6 and his profile was most consistent with anomic aphasia (with a fluency rating of 6, reflecting residual reduction in grammatical complexity of utterances).

Immediately prior to the initiation of the combined treatment for reading and spelling, a 6-week trial period of Oral Reading Treatment was implemented. At that time, BB's reading of written text was slow and prone to errors. In response to ORT, he improved reading accuracy for practised text from an average of 76.2% words correctly read (range = 49.3–93%) to 93.1% accuracy (range = 91–95%). Reading rate improved as well, from an average of 23.2 words per minute (wpm) (range = 17.2–34.66) to 39.3 wpm (range = 31.4–46.74). These preliminary data served to confirm that BB was a good candidate for ORT. The reading treatment was combined with CART for spelling because of BB's expressed interest in improving spelling abilities while continuing to improve reading skills.

Pre-treatment assessment

Administration of the *WAB* immediately prior to treatment yielded an aphasia quotient of 77.6 with a borderline fluent aphasia that was classified as anomic aphasia. His spoken description of the *WAB* picnic scene included some grammatically correct utterances,

Figure 1. MRI head scan for BB showing large lesion in the left perisylvian region.

such as ''It's a boy and girl having lunch'', some sentences of reduced grammatical complexity, and paragrammatic utterances, such as ''on the sailboating''. An analysis of the picture description was completed using *Systematic Analysis of Language Transcripts 6.1* (SALT 6.1; Miller & Chapman, 2000), an adapted version of Nicholas and Brookshire's (1993) rules for editing language transcripts, and an adapted version of Hunt's (1965, 1970) analysis of syntactic length and complexity. BB spoke in one-word utterances nearly one-third of the time and had an MLU of 3.62, and only one-third of his utterances could be considered grammatically correct.

The first five levels of the *Gray Oral Reading Test – 3* (*GORT-3*; Wiederholt & Bryant, 1992) were used to assess reading accuracy, rate, and comprehension of written text. BB's oral reading accuracy was slow and laborious at 26.6 words per minute, with frequent word identification errors (85.6% of words correct). His response to reading comprehension questions averaged 60% correct.

Single-word reading and spelling were assessed using a 120-word list balanced for frequency, regularity, and word length. BB's single-word reading accuracy was 93% correct, compared to only 9% correct for spelling of the same words presented for writing to dictation. There was no effect of word frequency or regularity on either reading or spelling accuracy, although the few words spelled correctly tended to be high frequency (7/40) rather than mid to low-mid frequency (2/80). When presented an additional list of 20 functors, BB correctly read 14/20 (70%) correctly, but was able to spell only 2/20 (10%). Single word reading errors were predominantly visually similar words (e.g., *shovel* for *shove*) and functor substitutions, whereas spelling errors were phonologically implausible attempts that were not real words (e.g., *ble* for *broom*). In addition, 20 nonwords were used to examine BB's phonological skills for reading and spelling. He was able to read only 2/20 (10%) nonwords, and no nonwords were spelled in a phonologically plausible manner. Thus, his reading and writing profile was consistent with phonological alexia and global agraphia (Beeson & Hillis, 2001; Ellis, 1993).

Treatment

Treatment procedure. Treatment sessions were conducted twice per week for 1 hour over 10 weeks, for a total of 19 sessions. Because of the differential level of impairment in reading and spelling, reading was treated at the text level, and spelling was treated at the single word level. The oral reading treatment was conducted during the session, with daily homework assigned. The spelling protocol was trained and then completed at home as outlined below.

Stimuli. Seven personally relevant scripts were constructed with input from BB, ranging in length from 73 to 156 words. BB provided the topic and information contained in each script. The clinician recorded the content and constructed a grammatically correct passage for each of seven topics, which included family, hunting, sports, Tucson, cars, jobs, and current activities. The scripts were typed in size 16 font and double-spaced. In the example that follows, the words in bold were those that were targeted for the concurrent spelling treatment.

> I used to ''hot-rod'' **cars** years ago. I was a drag racer. I won a lot of races on the streets, but not as many on the drag strip. Gary was the one who souped up my cars. I used to own a '23 **Ford**, a '39 Ford, and a '56 Ford. The '39 was my favorite, although I also liked the '56. I also had a '65 **Corvette**, but I only drove it once before I had to put a new **engine** in it. Racing is hard on cars. My friends **Billy**, Bryant, and many others raced cars, too.

Oral Reading Treatment (ORT). Printed text for each sentence of the scripts was placed in a photo album with a recording feature for each page (Talking Pictures 24, Sharper Image™). The text was accompanied by the corresponding spoken recording of each sentence. During the treatment session, reading accuracy was trained using the following steps:

- The clinician read a sentence of the target script aloud while pointing to each word.
- BB and the clinician read the sentence aloud together (i.e., using choral reading), with the clinician pointing to each word.
- BB read the sentence aloud alone, pointing to each word. The clinician called attention to errors by pointing, allowing BB to self-correct, or the clinician provided the correct model as needed.
- BB repeated oral reading of the sentence until mastery was achieved (100% correct).
- The procedure was implemented for each sentence of the script, and then the script was read in its entirety until mastery was achieved (i.e., reading the entire script aloud without error).

Reading homework was to be completed every day. Using the Talking Pictures photo album, BB was instructed to do the following:

- Play the recording and read along silently.
- Read the sentence aloud with the recording until you are correct (choral reading).
- Read the sentence aloud without the recording until you are correct.

Copy and Recall Treatment (CART). A total of 50 words were targeted over the course of treatment. From each of the first three scripts, 10 words were chosen that were used for reading treatment (30 total). For the subsequent four scripts, only five words per script were targeted for spelling treatment because the growing corpus of words was becoming too large for daily homework practice. In the script above about cars, the words targeted for written spelling included: *cars*, *Ford*, *Corvette*, *engine*, and *Billy*. These words were selected by BB and a list was generated for homework. Instructions to BB were as follows:

- Copy one of the target words 3–5 times (until ready to attempt recall from memory).
- Write the word from memory (recall).
- Check spelling by comparing it to the homework list and make corrections.
- Repeat the procedure until recall is correct, then move to the next word.

Probes. At the beginning of each treatment session, probe data were collected for reading accuracy (in percent of words correct), reading rate (in words per minute), and spelling accuracy for targeted words (in percent of words correct). Mastery for a given script was considered to be 90% accuracy for reading. At session 13, a criterion for reading rate was introduced at 60 wpm to increase task difficulty and to promote naturalness of oral reading. After a script was mastered, a new script was introduced, and the associated words were entered into CART.

Data analysis

Treatment effect sizes were used to determine the degree of change in BB's pre–post treatment performance for reading accuracy and rate for the narrative scripts, and spelling accuracy for targeted words from the scripts. The *d* statistic was calculated using the

approach recommended by Busk and Serlin (1992; equation 1) for single case research to provide a standardised index of treatment outcomes. Because there is not a standard metric for the interpretation of single case treatment effect sizes, we evaluated the magnitude of the effect sizes relative to the benchmarks suggested by Barcikowski and Robey (1985; Robey, 1994) for within-group treatment effects, where 0.63, 1.58, and 2.53 correspond to small, medium, and large effects, respectively. Significance testing was not performed because the repeated measures were not independent and the sample size was too limited for a time series analysis.

Reliability. To ensure reliability of error coding for reading accuracy, two speech-language pathologists independently scored all 24 of the transcribed reading samples. Instructions for coding oral reading errors were reviewed prior to scoring. Inter-rater reliability was 97.5%, and discrepancies were resolved through discussion. The first author also calculated intra-rater reliability by re-analysing the oral reading errors, with a period of 4 months between ratings. Intra-rater reliability was 98.8%.

RESULTS

Reading

As shown in Figure 2, accuracy for initial reading of the scripts ranged from 69% to 85.1% accuracy, with an average of 79.1%. Reading errors were predominantly functor substitutions and some visually similar words. In response to ORT, BB improved reading accuracy for each script, reaching 90% accuracy or better, yielding a large effect size (see Table 1). Follow-up probes collected during sessions 8 and 16 showed maintenance of gains even without repeated practice, which was discontinued once mastery was achieved. Reading rate also increased for targeted scripts, with an average rate of 43.7 wpm (range = 21.2–77.3 wpm) for initial readings, and an average rate of 61.5 wpm after treatment (range = 48.7–72.5 wpm), with a corresponding small effect size (see Table 1). As shown in Figure 3, BB's reading rate continued to increase without repeated practice (see follow-up probes). Taken together, these findings indicate that BB's increase in reading rate was not at the expense of reading accuracy.

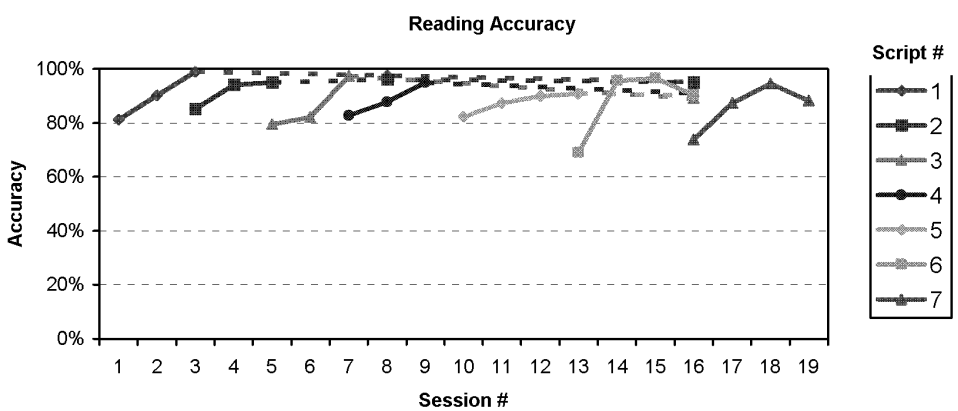

Figure 2. Reading accuracy in percent of words correct for text. Solid lines = probe data collected during treatment of the passage. Dotted lines = follow-up probe data.

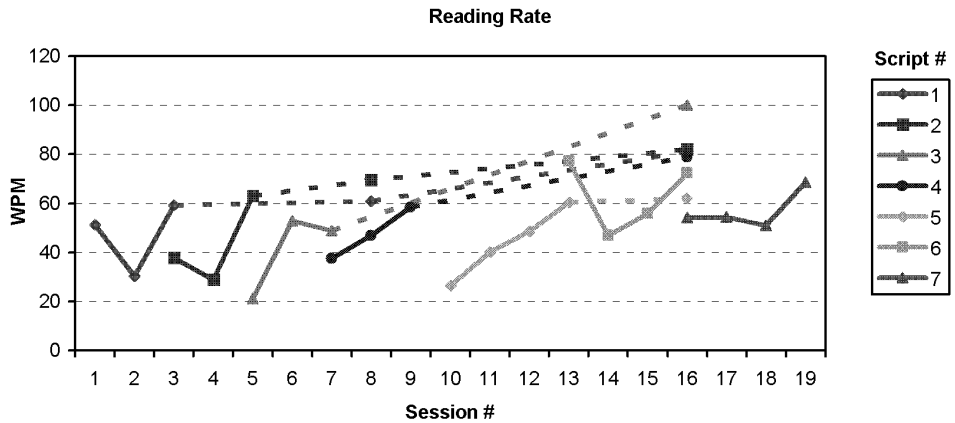

Figure 3. Reading rate in words per minute (wpm). Solid lines = probe data collected during treatment of the passage. Dotted lines = follow-up probe data.

Spelling

Seven sets of words were targeted for spelling treatment, comprising a total of 50 words. Figure 4 shows that BB improved on all seven sets over the course of 19 sessions. A follow-up probe on Session 8 showed a decline in spelling performance on targeted words from Script 1, so maintenance for previously mastered words was incorporated into the homework programme. A second follow-up probe (Session 16) reflected maintenance of mastered spellings with repeated practice. Overall, the magnitude of the effect size for improved spelling performance was large (see Table 1).

Post-treatment assessment

Several additional quantitative and qualitative indices of BB's response to treatment were obtained. On an alternative form of the *GORT-3*, BB's average reading accuracy showed positive changes in reading new text that were consistent with his performance on the

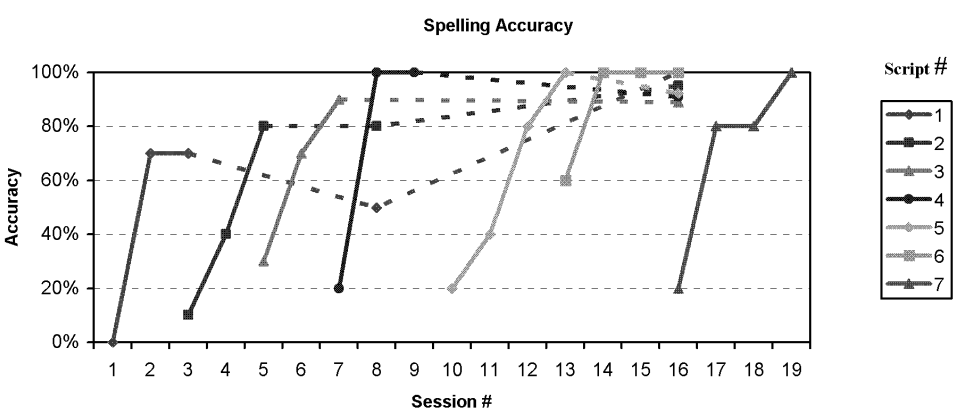

Figure 4. Spelling accuracy at the single word level over the course of treatment. In scripts 1–3, 10 words were selected per script for spelling treatment. In scripts 4–7, five words were selected per script for spelling treatment. Solid lines = measures taken during treatment of the script. Dotted lines = follow-up probes.

TABLE 1
Performance before and after treatment

	n		*Mean*	*Standard Deviation*	*d Statistic*	*Magnitude of effect*
Reading accuracy (script) in % correct	7	PreTx	79.3	5.8	2.51	Large
	7	PostTx	93.7	3.9		
Reading rate (script) in wpm	7	PreTx	43.6	19.0	0.94	Small
	7	PostTx	61.5	7.7		
Spelling accuracy in % correct	7	PreTx	22.9	18.9	3.63	Large
		PostTx	91.4	12.1		

Accuracy and rate for oral reading of personal scripts, and spelling performance for targeted words before and after treatment. n = number of observations; *d* statistic calculated as a standardised index of change.

practised scripts (85.6% → 93.4% accuracy), although reading rate remained slow, averaging 24.4 wpm (see Figure 5). Reading comprehension as measured by multiple-choice questions on the *GORT-3* also showed some improvement (60% → 76%). It was interesting to note that reading of functors improved from 70% to 100%, and writing of those functors improved from 10% to 50% (Fisher's exact probability = .02 and .01, respectively).

Re-administration of the *WAB* showed that BB's aphasia quotient increased from 77.6 pre-treatment to 84.1 after treatment, evidencing clinically significant gains. BB's improvements were most notable in the areas of spoken language production (information content, fluency, naming, and repetition). Additionally, the *WAB* picture description and a conversation sample were analysed for syntactic length and complexity using SALT and T-unit analysis. As shown in Table 2, BB's MLU increased from 3.62 to 7.4 on the picture description task, and to 9.47 during conversation, with few instances of one-word utterances. His productivity for spoken language improved as measured by a ratio of the number of usable words (i.e., excluding fillers) to the number of total words, as did the complexity of his utterances measured by a ratio of the number of words in T-units to the total usable words (see Table 2).

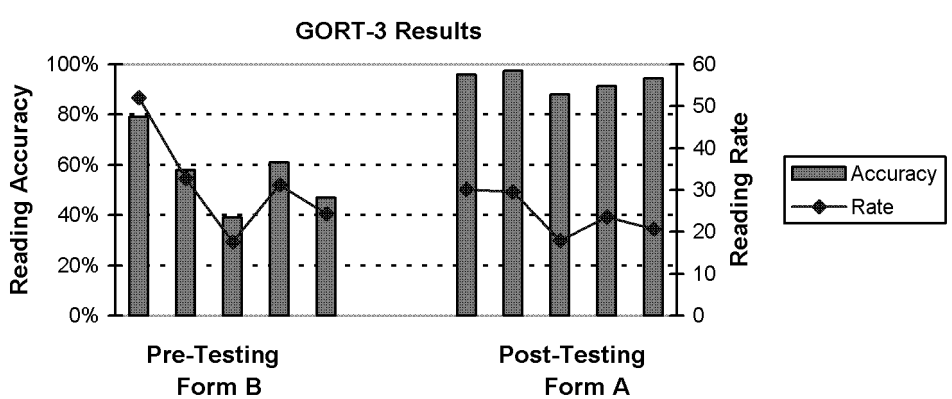

Figure 5. Results of the *GORT-3* for reading accuracy ((total words—errors)/total words) and rate in words per minute (wpm).

TABLE 2
Analysis of spoken language during spoken picture description and conversation

	WAB picture description			*Conversation*
	Pre-treatment	*During treatment*	*Post-treatment*	*Post-treatment*
MLU in words	3.62	6.32	7.4	9.47
One-word utterances (in % of total utterances)	30.77%	4.55%	8.33%	0%
Words per T-unit	5.00	5.69	5.2	5.96
Clauses per T-unit	1	1	1	1.06
Words per clause	5.00	5.69	5.2	5.62
Subordinate clauses	0	0	0	3 (adverbial)
Productivity	69.1%	64.4%	79.5%	81.7%
Grammatically of T-units	33% grammatical	100% grammatical	100% grammatical	98% grammatical
Index of syntactic complexity	39%	72%	83.9%	80%

MLU = mean length of utterance; Grammaticality of T-units = (# grammatical T-units/total # of T-units); Productivity = (# of usable words/# of total words); Index of syntactic complexity = (# of words in T-units/total usable words).

DISCUSSION

The aim of this study was to examine the therapeutic value of a combined treatment for reading and spelling. With regard to the targeted stimuli, BB achieved high levels of accuracy for reading text and spelling single words. In addition, his reading rate for practised text improved to about 60 wpm. Follow-up probes showed that reading accuracy for the targeted text remained high, and reading rate continued to improve without additional practice. Although BB also demonstrated the ability to relearn the spellings of personally relevant words, continued practice was required for the maintenance of newly learned spellings during this 10-week period.

Post-testing revealed that BB showed improvement in reading accuracy for new text, although his oral reading rate remained relatively slow at about 25 wpm. It was noteworthy that BB's improvement in reading accuracy was most marked for function words, and that his reading and spelling performance improved on a list of functors that were not specifically trained. Thus, it appeared that the repeated oral reading of text-level scripts served to strengthen recognition and spelling of functors. Similarly, measures of BB's spoken language revealed increased syntactic complexity and utterance length, both in conversation and *WAB* picture descriptions. This effect was most likely related to the repeated rehearsal of grammatically correct, personally relevant sentences in the scripts. In effect, the scripted passages provided syntactic stimulation that served to strengthen BB's relatively weak grammatical abilities. Cherney (1995) also suggested that oral reading of sentence-level text might facilitate improved ability to produce grammatically correct utterances. The effect may be similar to that achieved by the repetition of grammatical sentences as a component of syntax treatment protocols, such as the Helm Elicited Program for Syntax Stimulation (HELPSS; Helm-Estabrooks & Albert, 2004). It was noted that on numerous occasions during and after treatment, BB appropriately

produced sentences from his scripts in conversations. For example, he used the phrase ''I have two granddaughters, [name] who is seven, and [name] who is five,'' when asked about his family. When discussing models of cars he had raced, he replied, ''The '65 Corvette had to have a new engine in it,'' and expanded upon this scripted utterance by adding ''It was a lemon.''

In summary, this 10-week treatment resulted in impairment-level and functional improvement in communication for BB. It was interesting that although the focus of treatment was on written language, ORT also appeared to facilitate improved oral language. Clearly, continued treatment is appropriate for BB with the goal of approximating more normal language performance. Of interest will be whether reading rate and comprehension for new text improves significantly over time. With regard to spelling, CART should continue to increase his corpus of available written words, but efforts might be directed towards strengthening phonological reading and spelling abilities that remained markedly impaired. In conclusion, we suggest that the concurrent treatment of ORT and CART offers an efficient approach to language intervention that serves to enhance the processing of both written and spoken language. Continued research using this approach is warranted.

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