Successful single-word writing treatment: Experimental analyses of four cases

Pelagie M. Beeson, Fabiane M. Hirsch, and Molly A. Rewega

Department of Speech and Hearing Sciences, University of Arizona, USA

Background: Individuals with severe aphasia may fail to regain spoken language, so that treatment should target other communication modalities such as writing. There is relatively limited documentation of successful writing treatment, particularly in individuals with severe aphasia.

Aims: The present study was designed to examine treatment outcomes in response to two writing treatment protocols intended to rebuild single-word vocabulary for written communication.

Methods & Procedures: Writing treatments were implemented with four individuals who had significant aphasia and severe agraphia. Two participants received Anagram and Copy Treatment (ACT) which involved arrangement of component letters and repeated copying of target words, along with a homework programme called Copy and Recall Treatment (CART) that included copying and recall of target words. The other two participants received the homework-based CART only. Single-subject multiple-baseline designs were used with sets of words sequentially targeted for treatment.

Outcomes & Results: All four participants responded positively to treatment. Three of the participants had severely limited spoken language, so that mastery of written words provided a much-needed means of communication. The fourth participant, who had adequate spoken language for face-to-face conversation, employed his improved spelling for written messages such as e-mail.

Conclusions: Single-word writing abilities may improve with treatment despite long times post onset and persistent impairments to spoken language.

Individuals with significant aphasia typically experience disruption of both spoken and written communication because common language processes are impaired, or there is concomitant damage to both output modalities. In such cases, aphasia therapy is most often directed toward speech rather than writing because spoken language is the preferred modality for face-to-face communication. However, when spoken language is severely impaired, writing may be more amenable to treatment than speech. One such case was reported by Beeson (1999) in which a man (ST) with chronic, severe Wernicke’s aphasia mastered written spelling of a large corpus of words that provided a means to convey substantive information. ST received a clinician-directed treatment that required arrangement of component letters presented in scrambled order (i.e., an anagram) to form the target word, followed by repeated copying of the word. This procedure, referred
to as Anagram and Copy Treatment (ACT), was patterned after other lexical approaches to agraphia treatment (Aliminosa, McCloskey, Goodman-Schulman, & Sokol, 1993; Carlomagno, Iavarone, & Colombo, 1994; Hillis, 1989). ACT was complemented by a rigorous homework protocol that included repeated copying and recall trials for the target words, referred to as Copy and Recall Treatment (CART). Subsequently, ST also responded to a homework-based CART protocol without the anagram treatment.

ST’s improvement was specific to words that were targeted for treatment rather than a generalised improvement in spelling, suggesting a strengthening (or rebuilding) of his memory for specific spellings. According to cognitive models of spelling (Ellis, 1988; Rapcsak & Beeson, 2000; Shallice, 1988), this memory store of learnedspellings, referred to as the graphemic output lexicon (or orthographic output lexicon), can be accessed directly from the semantic system as depicted in Figure 1. The link between semantics and the graphemic output lexicon (pathway B in Figure 1) is critical for conceptually mediated writing tasks, such as spontaneous writing and written naming. This lexical-semantic spelling route also supports writing to dictation by connections between the phonological input and graphemic output lexicons via the semantic system (pathways A and B in Figure 1). The graphemic representation must be strong enough to persist in short-term memory (the graphemic buffer) as appropriate letter shapes are selected for writing, or the component letters are arranged for anagram spelling as shown in Figure 1. When writing a word, the abstract graphemic information is converted to specific letter shapes (allographs) that are formed by handwriting movements guided by the appropriate graphic motor programs.

Spelling may also be accomplished in a manner that bypasses semantic and orthographic representations, and relies on sound-to-letter (i.e., phoneme–grapheme) conversion rules. This phonological spelling procedure requires the segmentation of the auditory input into its component sounds and the translation of each phoneme to the corresponding grapheme (via pathways C and D in Figure 1). In the case of ST, these non-lexical spelling procedures were not available, and he was unable to produce the appropriate phonology for any of the target words. Thus, it appeared that writing treatment served to strengthen specific representations in the graphemic output lexicon that ST was able to access via semantics.

ST’s success was the impetus for a series of additional individual treatment studies reported here, which allowed us to determine the applicability of these procedures to others with aphasia and severe agraphia. The ACT and CART approaches used in these studies rely heavily on repeated exposure and practice with targeted words in a manner that is consistent with many aphasia treatments. Despite the fact that these treatments are not particularly novel, the documentation of successful remediation of acquired agraphia in this manner is limited (for review, see Beeson & Hillis, 2001). Particularly lacking is evidence to support successful remediation of agraphia in individuals with severe aphasia.

In the present study, we examined the effects of the clinician-directed ACT complemented by the homework-based treatment (CART) with two individuals with global aphasia. In order to determine the value of the predominantly homework-based CART treatment, two additional participants were examined using CART alone (without the ACT component). One of the participants who received only CART had severe Broca’s aphasia, while the other had aphasia of moderate severity. All four individuals also participated in weekly aphasia group therapy, which provided an opportunity to observe their communication strategies in a conversational context, but those sessions were not a time of formal data collection.
Figure 1. A cognitive model of language processing. See text for details.
METHOD

Single-subject multiple-baseline designs were implemented to examine the effects of ACT and CART. Treatments were administered by the authors who are certified speech-language pathologists, either directly or in collaboration with graduate students in speech-language pathology. The ACT and CART procedures were implemented in a standard manner, but there was some variation across participants regarding the frequency and duration of treatment, and the number of words targeted for treatment. One participant (FD) was scheduled once a week for treatment, whereas the other three participants were scheduled twice a week. Target words were selected by participants and their family members in collaboration with their speech-language pathologist. Functional significance was the primary factor determining word selection; lists included predominantly common nouns as well as some verbs, proper nouns, and other parts of speech (see Appendix). A minimum of 20 words (four sets of five words) was targeted for treatment for each participant. The treatment for two participants (AD and ED) was extended to include a total of seven sets of words.

Pre-treatment assessment

Prior to the initiation of writing treatment, a sample of single-word writing and reading ability was obtained from each participant. Written naming of common pictured items was measured using Subtest 53 from the Psycholinguistic Assessments of Language Processing in Aphasia (PALPA; Kay, Lesser, & Coltheart, 1992), with the exception of AD, who received an analogous test from the Johns Hopkins University (JHU) Dysgraphia Battery (Goodman & Caramazza, 1986/2001). Writing to dictation was assessed using PALPA Subtest 31, which controls for imageability and frequency of stimulus items. Single-word reading comprehension was assessed using PALPA Subtest 48 which requires matching a written word to an appropriate picture from a field of five. Recognition of written words was tested using a visual lexical decision task (PALPA Subtest 25), which requires identification of 60 real words presented along with 60 nonword foils. Information from additional measures of language and cognition that was available for the participants in this study is described for each case as well.

Anagram and copy treatment (ACT)

The ACT protocol is a cueing hierarchy used to elicit correct spelling of target words. As shown in Figure 2, the participant is asked to spell a word depicted by a representative picture. Semantic information is provided by the clinician as the picture is presented in order to maximise the likelihood that graphemic representations are appropriately linked to semantics. For example, when the picture for “money” is presented, the clinician might say, “Money … you spend money at the store” or some other appropriate comment about money. If the target word is not written correctly, component letters are presented in random order for the participant to manipulate in order to spell the word. Following successful arrangement of the letters, repeated copying of the word is required (three times), as a means to strengthen memory for the spelling. Immediately following repeated copying of the word, all written examples of the target are covered or removed, and recall of spelling is tested successively three times. As noted in Figure 2, corrective feedback is provided by the clinician and repeated copying of the target word occurs throughout the protocol. For this study, ACT was complemented by daily writing homework using the procedures described in the next section.
Copy and recall treatment (CART)

The CART protocol was used to direct writing at home on a daily basis. Participants were given homework pages with drawings depicting target words and a model of the written word. They were instructed to repeatedly copy each target word in the space provided, so that each word was copied at least 20 times per day (6 days per week). The copying task was followed by a self-test of the recall for practised words on homework pages that included the target pictures and a blank line on which to label each picture. Participants...
were familiarised with CART procedures during their treatment sessions, and completed homework pages were reviewed by the clinician at each subsequent clinical session to confirm that CART was implemented at home. Although there was no way to confirm that the recall tasks were indeed accomplished without reference to a written model, inspection of the homework provided accountability for the repeated copying of target words.

Data collection and criteria

At the beginning of each treatment session, spelling of target words was probed by showing the picture and asking the participant to write the appropriate word. These data were examined for each participant to determine baseline performance and to demonstrate their responses to treatment. Once a set of words was entered into treatment, the criterion for mastery of the set was 80% correct (e.g., four out of a set of five words) over two consecutive sessions (or during one session for FD who was seen once per week). Word sets were sequentially entered into treatment following achievement of criterion with the preceding set.

**CASE REPORTS**

**Case 1: FD**

FD was a 55-year-old, right-handed man who experienced a left hemisphere stroke at age 53 that resulted in global aphasia and right hemiparesis (Table 1). A CT head scan revealed a nonhaemorrhagic infarct in the distribution of the left middle cerebral artery, and complete occlusion of the left internal carotid artery. FD was a monolingual English speaker who spent 25 years as a chief master sergeant in the US Air Force. After retiring from the military, he had worked as an insurance salesman and a cashier.

At 2 years post stroke, FD showed persistent global aphasia according to the criteria of the Western Aphasia Battery (WAB; Kertesz, 1982; Table 1), paresis of the right arm and leg, and no visual field defect. His spoken output was characterised by stereotyped reactive utterances, such as ‘oh yeah’, ‘sure’, and profanity. FD augmented such expressions with prosodic variation, facial expression, and a few gestures to convey general meanings. He had established use of a personalised communication book to convey some basic information such as his address or the bus route he needed to take. He was not using writing to communicate.

*Pre-treatment assessment.* Prior to the initiation of writing treatment, FD’s single-word writing ability was extremely limited for both written picture naming and writing to dictation (Table 2). Of the 40 items on the PALPA 53 and 80 items on the PALPA 31, FD wrote only two words correctly: *pig* and *cow.* His error responses typically reflected a failure to write anything or an attempt to draw the item. On fewer than 1% of his error responses, FD wrote a correct first letter, suggesting that he rarely had even partial knowledge of spelling. FD could not read aloud, and his ability to match a written word to its corresponding picture (from a field of five) was accurate only 50% of the time (PALPA 48). On the visual lexical decision task (PALPA 25), FD correctly identified all 1 Ideally all sets of target words would have been sampled at equal intervals during the pre-treatment phases; however, time constraints (as well as participant frustration caused by repeated failure on untrained words) influenced the experimenters to defer the probes for the later-trained words. Despite this accommodation, all word sets were probed during the sessions immediately preceding initiation of treatment for that set.
60 real words from a field of 120; however, he tended to accept nonwords as real words (see Table 2), suggesting some degradation of his graphemic input lexicon. Additional testing revealed that in contrast to his severely impaired writing and reading abilities, FD showed preserved nonverbal visual problem-solving abilities on the Raven’s Coloured Progressive Matrices (CPM; Raven, 1976) with a score of 31/36 (90th percentile).

**Treatment procedure and results.** A total of 20 words (15 nouns, 5 verbs) that had personal value for FD were selected for writing treatment (see Appendix). The words ranged in length from three to nine letters, and were divided into four sets of five words.
Prior to treatment, FD was unable to spell any of the words correctly; in fact, he produced very few correct letters for any of the words. After probing his spelling for the first three sets of five words over two sessions with no correct responses obtained, writing treatment was initiated for set 1. The ACT protocol was employed during weekly treatment sessions, and the CART approach was used for daily homework. As seen in Figure 3, FD showed stable baseline performance for all word sets prior to the initiation of treatment, and he showed rapid improvement in written spelling of target words as they were entered into treatment. After 9 weeks of treatment, FD had reached criterion for correct written spelling of all four sets of words.

Following treatment, FD’s writing ability was re-assessed using the PALPA subtests which included words that had not been trained. FD showed no improvement in written spelling for those untrained words (Table 2), which was consistent with the multiple baseline data suggesting that the treatment effect was specific to trained words. Although he showed no generalised improvement of writing for untrained words, FD showed functional changes in his use of writing for communication. He began to copy words from his communication book and other sources in order to communicate specific information. He also initiated learning of additional self-selected words. For example, he learned to write the names of his physicians and appropriately communicated an upcoming appointment to his clinician by writing the physician’s name. Thus, FD began to incorporate written communication as a modality to supplement his relatively empty spoken utterances. He also showed increased use of his communication book to point to written words to clarify on-line communication with the clinician. Following the conclusion of the experimental implementation of the writing protocol, FD continued to respond to this treatment approach in the context of weekly individual treatment sessions. Clinical records showed the acquisition of an additional 20 words (including nouns and verbs) over the course of 12 weeks.

Case 2: AD

AD was a 57-year-old, left-handed man who experienced a left hemisphere stroke at age 55 (Table 1). Medical records indicated a complete left internal carotid artery occlusion leading to acute ischaemic infarct of the left middle cerebral artery territory with damage to the left temporal lobe, left medial basal ganglia, and the head of the caudate nucleus. AD had a high-school education; prior to his stroke he had managed a restaurant and bar.

At 18 months post stroke, AD showed persistent global aphasia with apraxia of speech and moderately severe right hemiparesis. As shown in Table 1, AD’s performance on the WAB yielded an aphasia quotient of 12.3. His spoken output was characterised by perseverative utterances (e.g., “away there, away there”) and some appropriate reactive utterances (e.g., “hello”, “goodbye”, “what?”). His most successful expressive communication occurred through use of gestures and drawing. Attempts at writing were typically unsuccessful, although on a few occasions AD showed partial word-form knowledge in written attempts (e.g., he wrote Pho for Phoenix, and Clin for Clinton).

Pre-treatment assessment. Prior to initiation of the writing treatment, AD was able to write the name of only one item on the picture-naming task (Table 3). He produced no correct responses on the writing to dictation task, and it was discontinued after 10 consecutive failed responses due to his marked frustration. On most items, AD did not attempt to write anything, but he occasionally responded with an unrelated word (e.g.,
Figure 3. FD’s writing performance on weekly probes taken during baseline, treatment (ACT with CART), and maintenance for word sets 1–4.
cap for basket, pie for bed). He made one semantically related error (tea for cup). AD showed little evidence of partial word form knowledge in that his few attempts to write an initial letter for a word were typically incorrect. He was able to copy single words with fair accuracy (51/62 correct) with errors primarily in the form of single letter substitutions (e.g., b/d, a/e, e/r). His ability to convert words from uppercase print into lowercase print also was fairly well preserved (49/62).

Like FD, AD could not read words aloud, and his ability to comprehend written words was impaired as indicated by a score of 12/20 on PALPA Subtest 48 (Table 3). Some additional assessment was performed with AD to determine the status of nonverbal cognitive processes. He demonstrated well-preserved semantic knowledge on the Pyramids and Palm Trees test of semantic relations (Howard & Patterson, 1992; 49/52 correct). He also demonstrated age-appropriate visual memory on subtests of the Wechsler Memory Scale–Revised (Wechsler, 1987) including Tapping Forward, Visual Paired Associates, and Figural Memory. In addition, AD performed within normal limits on the Raven’s CPM (32/36).

**Treatment procedure and results.** As with FD, a single-subject, multiple-baseline design was implemented to examine AD’s response to ACT with CART to re-establish his ability to write 20 targeted words. In addition, AD received subsequent treatment for an additional 15 words using CART without ACT. AD’s target words ranged in length from three to eight letters (see Appendix).

During the first phase of treatment, four sets of words, including 15 nouns and 5 verbs, were trained. Repeated probes prior to treatment showed that AD correctly spelled no more than one word per set prior to treatment (Figure 4). AD was scheduled for two treatment sessions per week; however, actual attendance was 19 sessions over the course of 12 weeks. As shown in Figure 4, AD achieved mastery of the spelling for all four sets of words.

During the subsequent CART-only phase of treatment, three additional sets of words were trained (sets 5–7). Homework packets were provided by the clinician for each set of words as they were targeted for treatment. During twice-weekly sessions, AD’s spelling was probed for the new words, and his CART homework was reviewed. The remainder of each hour-long therapy session was directed towards training to promote AD’s use of single-word writing to communicate in conversation. During those sessions, it became evident that AD had some difficulty generalising the use of words that he had mastered to

<table>
<thead>
<tr>
<th>Modality</th>
<th>Task</th>
<th>Test</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write</td>
<td>Written picture naming</td>
<td>JHU Dysgraphia</td>
<td>1/29</td>
<td>4/29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PALPA 53</td>
<td>–</td>
<td>3/40</td>
</tr>
<tr>
<td>Write</td>
<td>Writing words to dictation</td>
<td>PALPA 31</td>
<td>0/10*</td>
<td>0/40</td>
</tr>
<tr>
<td>Read</td>
<td>Match written word to picture</td>
<td>PALPA 48</td>
<td>12/20*</td>
<td>23/40</td>
</tr>
<tr>
<td>Read</td>
<td>Lexical decision</td>
<td>PALPA 25</td>
<td>–</td>
<td>58/60 words</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>39/60 nonwords</td>
</tr>
</tbody>
</table>

JHU Dysgraphia = Johns Hopkins University Dysgraphia Battery; PALPA = Psycholinguistic Assessment of Language Processing in Aphasia. *indicates that not all items were administered due to participant frustration.
new contexts. For example, AD had learned to write the word *shoe* in response to a line drawing of a shoe, but when the clinician pointed to the shoe on her foot, AD was unable to generate the correct written word for this new exemplar. It appeared that he had developed highly specific associations between the pictured stimuli used for treatment and the written word. For that reason, some treatment time was spent showing AD multiple exemplars for the target words that he had learned to write in order to establish an association between the spelling and numerous referents for the word. This procedure was implemented concurrently with conversational interaction incorporating the use of writing, and appeared to resolve the semantic difficulty. Over the course of 6 weeks using
the CART protocol, AD mastered the targeted 15 words in sets 5–7. Follow-up testing documented good retention of spelling for all trained words. AD correctly spelled all 20 words learned with ACT and CART (tested at 2 months post-treatment) and all 15 of the words learned with CART alone (tested at 5 months post-treatment).

As shown in Table 3, AD’s performance on the post-treatment measures was not significantly changed from that prior to treatment. However, over the course of treatment, clinical observations revealed AD’s increased attempts to use writing to communicate in group and individual therapy sessions, with improved effectiveness in those attempts. In addition to his appropriate use of trained words, AD increasingly demonstrated partial word form knowledge for untrained words by writing some of the first few letters.

Following the clinician-directed CART, AD was guided to select words on his own to enter into CART. AD was given a picture dictionary (Parnwell, 1993) from which he could select words to learn to spell. AD kept a notebook for writing homework showing that he typically practised writing more than 50 words a day, including previously trained words and new words that he selected to learn. Thirteen months after the initiation of writing treatment, AD continued to target new words to learn and use in written communication.

**Case 3: LG**

LG was a 41-year-old, right-handed man who suffered a stroke that resulted in severe nonfluent aphasia, apraxia of speech, and right hemiparesis. A CT scan confirmed a large ischaemic infarct in the left middle cerebral artery distribution. LG was a monolingual speaker of English who had worked as a communications supervisor for an emergency medical service. One year after his stroke, he obtained an aphasia quotient of 21.3 on the WAB and a classification of Broca’s aphasia (Table 1). His verbal output was characterised by stereotyped utterances, intoned jargon, and some single-word productions. His auditory comprehension was moderately impaired. LG’s most successful communication modality was gesture accompanied by largely unintelligible speech.

**Pre-treatment assessment.** Prior to treatment, LG showed limited use of writing for communication, and had difficulty on tests of single-word writing. He correctly wrote the names of 9 out of 40 common objects on the written naming subtest (PALPA 53). His performance on the writing to dictation subtest (PALPA 31) was no better (4/32). LG’s error responses included implausible nonwords (such as *wigger* for *axe*) and unrelated real words (such as *work* for *cow*). Reading comprehension for concrete nouns was a relative strength for LG in that he correctly matched 33/40 pictures to the corresponding written word. LG performed close to normal on a lexical decision test for written words (PALPA 25; 57/60 words correctly selected, 56/60 nonwords correctly rejected). Other strengths for LG were revealed on the Pyramids and Palm Trees test of semantic knowledge (45/52), and the Raven’s CPM, which showed normal visual problem-solving abilities (31/36).

**Treatment procedure and results.** At the outset of treatment, LG demonstrated a high level of motivation to master the spelling of words that he and his wife selected. Given his enthusiasm and the fact that his residual abilities were greater than those of FD and AD, we increased the number of target words per set from five to seven (for the first four sets of words). As shown in Figure 5, relatively stable baselines were documented for each set prior to treatment. The CART protocol was implemented with LG for the
targeted words; he received only CART and was not exposed to ACT. He was seen twice a week to probe spelling performance and assure that he was completing the CART homework appropriately. LG learned the spellings of targeted words fairly rapidly as shown in Figure 5. As he was nearing criterion for the fourth set of words, another 18 words were targeted for treatment (three sets of six words). As shown in Figure 5, sets 5–7 were trained to criterion after seven sessions. The 46 words mastered by LG ranged in length from three to nine letters (see Appendix).
On the post-treatment assessment, LG showed little improvement in his spelling of untrained words (Table 4). It was noteworthy, however, that during treatment, LG showed a notable increase in his attempts to spell untrained words in the context of group therapy. He showed increasing ability to write the initial portion of words and to spell some words that had not been targeted for treatment. Therefore, despite the fact that the experimental paradigm showed no generalisation to untrained items, there was anecdotal evidence to suggest some improvement in LG’s access to graphemic representations.

**Case 4: ED**

ED was a 39-year-old, left-handed man with a history of arteriovenous malformation (AVM). He had attended college and worked as general manager of a chain of appliance stores prior to the onset of aphasia. At age 34 he underwent surgery for the AVM which resulted in a haemorrhagic stroke that produced moderately severe Broca’s aphasia and right hemiparesis. At 5 years post-stroke, ED’s spoken output was characterised by slowly produced utterances with simplified grammatical structure that were relatively high in content. His auditory comprehension was relatively good, and his WAB aphasia quotient was 75.6. At that time, ED’s aphasia type was classified as anomic, rather than Broca’s, because of his use of some grammatical structures in spontaneous speech. Word-finding difficulties were common and ED occasionally wrote the first letter of a word and some proper names to supplement his spoken utterances. Writing was accomplished with his dominant left hand, so that graphomotor skills were unimpaired. Although ED’s primary mode of communication was spoken, he was motivated to work on written spelling so that he could compose e-mail messages.

**Pre-treatment assessment.** ED’s single-word writing ability was markedly impaired. He correctly wrote the names of 7 out of 40 pictured objects on the PALPA 53 subtest. Writing to dictation was no better, with only 3 out of 80 items correctly spelled (Table 5). Most of ED’s responses were attempts to write the first letter of the word; he was correct about half of the time. Despite ED’s ability to repeat words and to name pictures of common objects, he showed no ability to use phoneme-grapheme conversion for spelling. This was tested directly using nonwords from the PALPA Subtest 45. ED was unable to write any pronounceable nonwords (i.e., pseudowords such as *flig*) presented by dictation. ED’s single-word reading was good for common nouns as indicated by correct matching of 39/40 written words to the appropriate picture (PALPA 48). On the lexical decision task for written words, ED correctly identified 56/60 words and 48/60 nonwords, suggesting a mild impairment in word recognition.

<table>
<thead>
<tr>
<th>Modality</th>
<th>Task</th>
<th>Test</th>
<th>Pre-treatment</th>
<th>Post-treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Write</td>
<td>Written picture naming</td>
<td>PALPA 53</td>
<td>9/40</td>
<td>10/40</td>
</tr>
<tr>
<td>Write</td>
<td>Writing to dictation</td>
<td>PALPA 31</td>
<td>4/32*</td>
<td>3/80</td>
</tr>
<tr>
<td>Read</td>
<td>Match written word to picture</td>
<td>PALPA 48</td>
<td>33/40</td>
<td>33/40</td>
</tr>
<tr>
<td>Read</td>
<td>Lexical decision for written words</td>
<td>PALPA 25</td>
<td>57/60 words</td>
<td>57/60 words</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>56/60 nonwords</td>
<td>54/60 nonwords</td>
</tr>
</tbody>
</table>

PALPA = Psycholinguistic Assessment of Language Processing in Aphasia. * indicates that not all items were administered.
Treatment procedure and results. ED was treated with a homework-based treatment employing the CART protocol. He was seen twice a week to assess his progress and to give him his weekly homework packets. As with the other participants, a multiple baseline design was used to determine if accurate spelling of targeted words occurred in response to treatment. As shown in Figure 6, ED mastered correct spelling of 15 targeted words (sets 1–3) during the first 6 weeks of treatment. The baseline was extended prior to initiation of the fourth set of words in order to determine if generalisation might occur. As the baseline remained stable, the fourth set of words was entered into treatment and quickly mastered by ED. Over the course of 9 weeks, ED mastered the spelling of 20 words.

On the post-treatment assessment, ED did not show a significant change in spelling ability for untrained words, suggesting that the treatment was item-specific. The improvement in spelling was adequate, however, to get ED started in the use of e-mail. Given that his spelling competence was still limited, he copied the spellings for untrained words from written sources or obtained help from family members. He wrote the messages by hand and then typed them into the computer. ED’s e-mails were agrammatic but meaningful, and had the benefit of evoking a response from the recipient, thus enhancing his social interaction with others. It was also noted that ED increased use of writing during conversation, and in some instances his writing served to cue his retrieval of a spoken word during instances of anomia.

DISCUSSION

The purpose of this study was to examine the value of ACT and CART as treatment approaches to re-establish single-word writing in patients with aphasia. The positive outcomes with the four participants reported here, and ST reported by Beeson (1999), demonstrate the potential value of these relatively simple clinical procedures. Prior to treatment, the participants showed minimal ability to write words, but demonstrated rapid learning for written spelling of the words targeted in treatment. All four participants were able to master the targeted words, despite severe aphasia in three of them. Participants FD and AD responded well to treatment using ACT with CART, and AD acquired additional spelling knowledge using CART alone. With LG and ED, we documented that CART alone can be a successful treatment without ACT.

The response to treatment was item-specific in that there was minimal evidence of a generalised treatment effect to untrained words within the period studied for any of the participants. As with ST (Beeson, 1999), we suggest that ACT and CART served to strengthen specific graphemic representations and the ability to access them. All participants were able to master the spelling of words of varying lengths, suggesting

| Table 5: Participant ED’s pre- and post-treatment performance on selected measures |
|---------------------------------------------|---------------------------------------------|
| **Modality** | **Task** | **Test** | **Pre-treatment** | **Post-treatment** |
| Write | Written picture naming | PALPA 53 | 7/40 | 3/40 |
| Write | Writing to dictation | PALPA 31 | 3/80 | 6/80 |
| Read | Match written word to picture | PALPA 48 | 39/40 | 40/40 |
| Read | Lexical decision for written words | PALPA 25 | 56/80 words | 51/60 words |
| | | | 48/60 nonwords | 51/60 nonwords |

PALPA = Psycholinguistic Assessment of Language Processing in Aphasia.
adequate function of the graphemic buffer. In addition, their rapid learning of target words showed no evidence of impairment to peripheral writing procedures including allographic conversion or the implementation of graphic motor programmes (Figure 1). Two participants (FD and LG) had to overcome the awkwardness of writing with the nondominant hand, but that did not pose a major hindrance.

Assuming that graphemic representations were strengthened by the writing treatment, the associated semantic information must also be available in order for single-word

Figure 6. ED’s writing performance on probes taken during baseline, treatment (CART), and maintenance for word sets 1–4.
writing to be used meaningfully. During ACT treatment, pictures were presented along with the spoken name and descriptive information with the intention of activating associated semantic representations. In CART, the written naming of the target pictures should also have served to strengthen the links between semantics and orthography. However, despite our efforts to promote semantic–orthographic links, the copying of target words could be accomplished without activation of associated word meaning. In fact, midway through the treatment, we began to suspect that AD had relatively weak links between semantics and the target orthography. When treatment was adjusted to further emphasise semantic meanings by showing multiple exemplars for each target word, AD responded positively. Thus, we observed that some individuals require additional semantic treatment to ensure that orthography is adequately linked to semantics, whereas others do not. It is likely that significant damage to the semantic system would limit meaningful use of single-word writing for communication.

The performance of LG and ED using CART without ACT served to confirm that CART alone can result in positive outcomes similar to that of ACT with CART. Given that CART relies predominantly on homework and requires less direct clinical training than ACT, and thus a minimal amount of clinical time, it may be the preferred clinical approach for writing treatment in many cases. In such instances, the bulk of treatment sessions might be directed toward other goals, thus maximising limited clinical time. Alternatively, we note that the ACT protocol offers a supportive cueing hierarchy that may better meet the needs of some patients when implemented in conjunction with CART, particularly during the initial stages of writing treatment. Regardless of which approach is used, our current data support the implementation of writing treatment with at least weekly sessions to confirm that homework is being completed properly and to initiate work on new items.

As noted, our participants showed predominantly an item-specific response to treatment, with little generalisation to untrained items that were probed or those items included in the pre- and post-treatment assessments. However, we noted increased use of writing as a means of communication for all four participants. For example, FD copied words from his communication book as he prepared for on-line interaction, and ED copied words from a variety of sources into his daily planner and into e-mail messages. In their weekly aphasia groups, AD, LG, and ED all made attempts to write untrained words during communication that provided evidence of partial word form knowledge (e.g., writing the first few letters of a word). Thus, it appeared that their mastery of a growing corpus of words motivated them to incorporate writing as a communication modality and to make use of residual graphemic information.

In our view, the item-specific treatment of single-word spelling using ACT with CART (or CART alone) is the first step of a multi-staged treatment plan. Once it is established that a participant responds positively to the single-word writing treatment, the homework-based treatment should continue over an extended period of time in order to build a corpus of written words usable for everyday interaction. Although the participants in this study targeted predominantly common nouns, we have subsequently noted that proper nouns, including names of family members and favourite restaurants, are often high-priority words. In order to maximise the functional benefits of writing treatment, we have found it necessary to include training in the use of single-word writing for conversational interaction. Although not the focus of this investigation, each of the three participants with severe language impairment also received training to promote the use of writing for on-line communication. In particular, they were encouraged to use single written words to respond to questions in a manner that approximated the give and take of
spoken communication. This aspect of writing treatment requires additional study as does determination of the best candidates for ACT and CART protocols.

REFERENCES

APPENDIX

Words targeted for treatment

FD
Set 1: home, book, phone, money, travel
Set 2: sick, base, sport, dinner, woman
Set 3: man, world, friend, television, basketball
Set 4: eat, buy, walk, drink, smoke

AD
Set 1: TV, paper, shoes, brother, football
Set 2: pen, wife, socks, glasses, bathroom
Set 3: dog, bed, shirt, house, children
Set 4: eat, walk, golf, kick, drink
Set 5: fan, book, woman, flower, cracker
Set 6: beef, water, chair, banana, picture
Set 7: soup, pool, music, juice, friend

LG
Set 1: eat, hot, pain, jeans, light, church, newspaper
Set 2: hat, shoes, phone, shorts, glasses, thirsty, outside
Set 3: bank, soup, razor, music, sports, cereal, Portland
Set 4: ocean, stamps, shower, Nonnie, chicken, pancakes, Bridget
Set 5: rock, game, racing, children, watching, supervisor
Set 6: born, family, hockey, country, computer, collecting
Set 7: drive, listen, friend, reading, dispatch, vacation

ED
Set 1: book, razor, light, apple, computer
Set 2: corn, shirt, music, pizza, football
Set 3: milk, pills, table, money, chicken
Set 4: cook, open, drink, sleep, drive