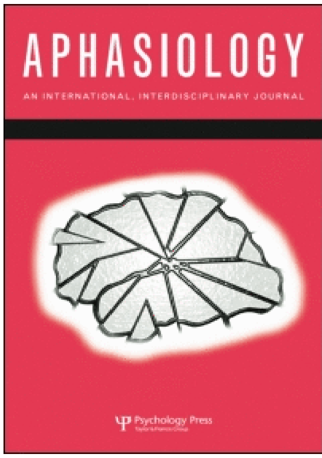

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Using a written cueing hierarchy to improve verbal naming in aphasia

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Using a written cueing hierarchy to improve verbal naming in aphasia

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Background: For some individuals with aphasia, writing has been used as an alternative modality for communicating (e.g., Clausen & Beeson, 2003; Lustig & Tompkins, 2002). In some investigations where writing ability was treated; post-treatment and/or anecdotal reports indicated that verbal naming ability also improved for participants with aphasia (e.g., Beeson, Rising, & Volk, 2003; Kiran, 2005). In some recent studies, investigators have reported that written naming cueing can improve verbal naming ability (DeDe, Parris, & Waters, 2003; Hillis, 1989).
Aims: The purpose of the present study was to examine the effects of a written cueing treatment programme on verbal naming ability in two adults with aphasia.
Method & Procedures: Treatment involved using a written cueing hierarchy, which was modelled after *Copy and Recall Treatment* (CART; Beeson, 1999) and included verbal and writing components. A modified multiple probe across behaviours design was used to document individual participants' response to treatment. The design was replicated across each participant and included baseline, treatment, probe, and maintenance conditions.
Outcomes & Results: Both participants improved their verbal naming ability for the target items over the course of treatment, but they responded differently to the treatment. One participant (P2) maintained verbal naming performance for the treated items 4 weeks after treatment ended and generalised to the untrained items; whereas the other participant (P1) did not.
Conclusions: Results support and extend previous findings that treating in one modality improves performance in a different modality. Further, participants responded differently to the treatment, suggesting that underlying differences in the participants' deficits may account for why they responded differently to the same treatment.

Anomia is the cardinal impairment of aphasia and it may manifest in both written and oral language modalities. In studies where writing was treated, post-treatment and/or anecdotal reports indicated that verbal naming ability improved for some participants with aphasia (e.g., Beeson et al., 2003; Hillis, 1989; Kiran, 2005).

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Pedersen, Vinter, and Olsen (2001) employed a computerised rehabilitation programme consisting of writing activities to treat anomia in individuals with aphasia. Results indicated that all participants improved their oral naming ability, although with different degrees of success. In recent studies, investigators reported that written naming cueing can improve verbal naming ability (DeDe et al., 2003; Hillis, 1989). The effect that treatment in the written modality has on verbal naming ability is explored further in the current study.

WRITING TREATMENTS

Kiran (2005) trained phoneme to grapheme conversion in three individuals with aphasia to improve their written production abilities. Two of the participants improved writing to dictation for trained and untrained words and some improvement was also found in oral naming ability. Kiran (2005) hypothesised that treating in multiple modalities may result in better outcomes because the connection between the phonological output lexicon and graphemic output lexicon is bidirectional.

Beeson and colleagues (Beeson, 1999; Beeson, Hirsch, & Rewega, 2002; Beeson et al., 2003) developed two treatments, *Anagram and Copy Treatment* (ACT) and *Copy and Recall Treatment* (CART) to improve spelling and writing in adults with aphasia. ACT is a clinician-directed approach to improve spelling via a cueing hierarchy. CART is also a method for training spelling and writing to improve written naming ability and is similar to ACT, but includes a homework component. In the studies using ACT and CART, Beeson and colleagues evaluated oral language ability as well as written language ability following treatment and found several positive results. For example, participants used writing to facilitate conversation (Beeson et al., 2003) and as a self-cue to orally generate the target word (Beeson et al., 2002). Beeson and colleagues (2003) suggested that CART may be an appropriate treatment programme for facilitating verbal naming abilities, and recommended combining verbal repetition with CART to stimulate oral language as well as written language abilities.

RELATIONSHIP BETWEEN WRITTEN AND VERBAL NAMING

Investigators have also directly examined the relationship between written and verbal naming (e.g., DeDe et al., 2003; Hillis, 1989). Hillis (1989) examined whether treating written naming ability would improve verbal naming ability with two participants with aphasia. Treatment involved two cueing hierarchies, one for written naming and one for verbal naming. The written naming cueing hierarchy was presented until the participant correctly wrote the name of the stimulus picture. The participant was also encouraged to say the word if possible, but criterion for success was not contingent on verbal production. The verbal naming cueing hierarchy included semantic cues, written cues, and phonological cues. Results indicated that one participant improved his verbal and written naming when he received the written naming treatment only, generalised in verbal and written naming of untrained nouns in the same semantic categories, and maintained naming ability after treatment ended. The other participant improved written naming of trained words, but did not generalise to untrained words or across modalities. Hillis (1989) suggested that the different results between participants might be due to the underlying differences in the participants' deficits.

DeDe and colleagues (2003) investigated the use of written and tactile cues on verbal naming ability in an individual with moderate-severe nonfluent aphasia and apraxia of speech. Treatment consisted of a confrontation naming task using a modified cueing hierarchy; the first part of the hierarchy included written cues and the second part included tactile cues. Criterion for terminating treatment was 80% accuracy for orally naming the target words. The purpose of the tactile cues was to facilitate word retrieval during apraxic episodes. The criterion was not met after 13 sessions and the participant's performance declined but remained above baseline levels after a 6-week break. DeDe et al. (2003) reported improvement on the written and naming subtests of the *Psycholinguistics Assessment of Language* (PAL; Caplan, 1992) following treatment, suggesting that some generalisation did occur. Although the study included only one participant and the cueing method was somewhat inconsistent, the results still hold promise. That is, findings from the study indicate that written naming cueing can improve verbal naming ability. The gains were not as high for verbal naming as for written naming and did not reach the criterion level; however, some improvement did occur.

FACTORS CONTRIBUTING TO SUCCESSFUL OUTCOMES

In the studies examining the effects of writing treatment on oral naming, either indirectly or directly (Hillis, 1989; Beeson et al., 2002; Beeson et al., 2003), it has been suggested that a preserved semantic system is necessary for writing treatment to be successful. Other factors felt to contribute to the success of writing treatment have included the use of personally relevant target words (DeDe et al., 2003; Lustig & Tompkins, 2002), completion of homework (Beeson et al., 2003), and the capacity to use writing as a form of communication before treatment (Lustig & Tompkins, 2002). Type and severity of aphasia were not good indicators of a participant's response to treatment (Beeson et al., 2003; Hillis, 1989). Hillis (1989), Beeson et al. (2002), and Beeson et al. (2003) included participants with nonfluent aphasia who responded well to the writing treatment and improved verbal naming. DeDe et al. (2003) included a participant with nonfluent aphasia and apraxia of speech (AOS) who demonstrated minimal gains.

The purpose of the present study was to examine the effects of a written cueing treatment programme on verbal naming ability in two adults with aphasia. Treatment involved using a written cueing hierarchy, which was modelled after CART and included verbal and writing components. A modified multiple probe across behaviours design was used to document individual participants' responses to treatment. Based on results of previous studies, it was expected that participants' oral naming ability would improve for treated items following treatment.

METHOD

Participants

Two adults with aphasia secondary to unilateral left hemisphere damage subsequent to a cerebrovascular accident (CVA) participated in the study. Participants met the following criteria: (a) aphasia, as confirmed by clinical diagnosis and performance on the *Western Aphasia Battery* (WAB; Kertesz, 1982); (b) documented naming deficit, as confirmed by performance on the WAB and *Boston Naming Test* (BNT; Goodglass, Kaplan, & Barresi, 2001); (c) preserved single word reading as demonstrated by performance on the *Reading Comprehension Battery for Aphasia-2* (RCBA-2; LaPointe & Horner, 1998); (d) onset of stroke at least 3 months prior to participation in the study; and (e) at initiation of study no known history of psychiatric or neurodegenerative diseases. Participants demonstrated normal uncorrected or normal corrected visual acuity as measured by the Snellen chart. Participants also passed a pure tone hearing screening at 30 dB HL bilaterally at 1000, 2000, and 4000 Hz. See Table 1 for participants' demographic and clinical data.

Participant 1 (P1) was a 76-year-old Caucasian female, 14 months post stroke at the onset of the study. Her native language was English, but she acquired other languages (Bengali and Swahili) as an adult. P1 was a homemaker and retired support services hospital worker. Two months after beginning the study, she was diagnosed with Guillain Barré syndrome and admitted to an in-patient rehabilitation facility. Clinical examination revealed that she did not present with additional speech and language deficits following this diagnosis and she requested she be allowed to continue with the study. Subsequently, she received three of her treatment sessions at an in-patient rehabilitation facility.

Participant 2 (P2) was a 76-year-old Caucasian female, who had a stroke 12 months prior to enrolment in the study. She was a high-school graduate, retired shoe designer, and hotel manager, and spoke only English. P2 was admitted to a nursing home due to the affects of her stroke, which left her unable to complete activities of daily living without assistance. However, she demonstrated preserved cognitive skills

TABLE 1
Participants' demographic and clinical information

	P1	*P2*
Age	76	76
Handedness	Right	Right
Gender	Female	Female
Years of education	17	12
Months post onset	14	12
WAB[1]		
Fluency	8.0	6.0
Auditory Comprehension	7.2	7.35
Repetition	3.8	2.6
Naming	3.6	5.2
Aphasia Quotient	61.2	56.3
BNT[2]	6.0	2.0
RCBA-2[3]		
Single Word - visual	10	9
Single Word - auditory	10	10
Single Word - semantic	10	10
Lexical decision	20	20

[1]Western Aphasia Battery; [2]Boston Naming Test; [3]Reading Comprehension Battery for Aphasia – 2. For the RCBA-2 raw scores are reported – for Single Word subtests the maximum raw score is 10, for Lexical decision the maximum raw score is 20.

as indicated by report in her medical chart and determined through informal assessment during initial testing. Based on their WAB performances as well as clinical diagnosis, both participants presented with conduction aphasia (see Table 1).

Stimuli development and selection

Stimuli used in treatment were pictures from Snodgrass and Vanderwart (1980). They are black and white pictures representing English nouns. Each participant was asked to name orally 70 pictures randomly selected on two separate occasions. If the participant did not respond, named the picture incorrectly, or responded after 20 seconds, then the response was scored as incorrect. A total of 40 pictures scored as incorrect across the two trials were selected as target words for the treatment study. These were randomly assigned to four 10-word lists: three treated and one untreated. The target words selected were not the same across participants (see Appendix for participants' target words). To ensure that the target word lists for participants were balanced for frequency of occurrence, a one-way analysis of variance comparing frequency of occurrence (Kucera & Francis, 1967) for each of the four lists for each participant was conducted before beginning the treatment phase of the study. Results indicated a non-significant effect, $F(3, 36) = 1.09$, $p = .36$, and, $F(3, 36) = 1.96$, $p = .14$, for P1 and P2, respectively and that stimuli across lists for each participant were similar for frequency of occurrence.

Experimental design

A modified multiple probe across behaviours design was used. The design was replicated across each participant. The design was modified to include initial testing, post-treatment probes, and a 1-month follow-up probe to assess maintenance. During training, the multiple probe design included baseline, treatment, and probe conditions. The baseline conditions consisted of presenting target words without feedback across three consecutive trials; initial baseline data were collected for all lists prior to initiating treatment, then a baseline condition preceded its respective treatment list. The treatment conditions consisted of training three lists of words using the written cueing hierarchy. The probe conditions consisted of presenting target words without feedback; these probes followed each of the three treatment conditions. After List 3 was treated and final probe data were collected, a 1-month follow-up session occurred to assess maintenance (Maintenance Condition). During this session, the standardised measures were also re-administered.

Written cueing hierarchy

Treatment involved using a written cueing hierarchy, which was modelled after CART (Beeson, 1999; Beeson et al., 2002; Beeson et al., 2003) (see Table 2). The cueing hierarchy was as follows: the participant viewed a picture and was asked, "Can you tell me what this is?" If the participant verbally produced the word correctly, he/she was asked to write the word. If the participant wrote the word correctly, the next picture was shown. If the participant was unable to write the word correctly, the written form was shown and the participant copied it three times. If copied correctly on all three attempts, the examples were removed and the participant attempted to write then verbally state the target from memory three

TABLE 2
Written cueing hierarchy

1. The participant viewed a picture from the training set and was asked, "Can you tell me what this is?" If the participant verbally produced the word correctly, she was asked to write the word. If the participant wrote the word correctly, the next picture was shown.
2. If the participant was unable to write the word correctly, the written form was shown and the participant copied it three times.
3. The examples were then removed and the participant attempted to write and verbally state the target from memory three times.
4. If the participant was unable to verbally produce the target word or if she produced it incorrectly, she was asked to write the word.
5. If the participant wrote the word correctly, then the next word was presented. If the participant wrote the word incorrectly, then steps 2 and 3 were repeated once.

times. While progressing through the three times, if the participant was unable to verbally produce the target word or if she produced it incorrectly, she was asked to write the word again. If the participant wrote correctly on all three attempts, then the next word was presented. If the participant incorrectly wrote the word, then the written form was shown, and the participant copied it three times. The examples were then removed and the participant attempted to write and verbally state the target from memory three times. For each participant, treatment included three different lists of target words, using the written cueing hierarchy.

Baseline

The number of baseline trials was set a priori: three trials for all lists prior to beginning treatment, then three trials for the respective list prior to treating it. However, P1's performance on List 3 increased by 40% in three trials, therefore a fourth trial was added. Each participant was shown the 40 target pictures from their respective lists and instructed to name the pictures. No feedback was provided to the participants following responses. If the participant incorrectly named the item then self-corrected within 20 seconds, the self-corrected response was scored. If the participant did not respond in 20 seconds or responded incorrectly, the item was scored incorrect and the next item was administered.

Treatment

Three lists each containing 10 words (Lists 1, 2, and 3) were trained sequentially and one list (List 4) was untrained and used to probe for generalisation. Treatment occurred two to three times per week and each session lasted approximately 1 hour. Criterion for terminating treatment for each list was 80% naming accuracy for 2 trials or completion of 10 trials for a list. Once criterion was met for List 1, the list was probed once. No feedback was provided. Then, List 3 was probed once and List 2 was baselined again for three trials. Next, training on List 2 began. After criterion was achieved for List 2, List 1 and List 2 were probed once and List 3 was baselined again for three trials. Training for List 3 then began. Treatment ended when criterion was met for List 3.

Generalisation and maintenance probes

After criterion was met for List 3, all lists (Lists 1–3) were probed once including the untreated list to assess generalisation. Then maintenance probing occurred approximately 4 weeks after the last treatment session. All treated and untreated lists were probed, and the WAB and BNT were re-administered.

Reliability

All sessions were video recorded. An independent observer viewed a randomly selected 40% of the total number of trials possible to assess procedural reliability. The independent observer compared her data to the investigator's data to ensure point-by-point agreement following the written cueing hierarchy including reliability for scoring response. The results revealed 96% agreement.

RESULTS

Participants' results are presented in Figures 1 and 2 and show the percentage of items correctly named for each list. Changes from baseline to treatment phases and baseline to maintenance phases were statistically analysed via a time-series analysis using C-statistic (Suen & Ary, 1989; Tripoldi, 1994; Tyron, 1982). Effect sizes, Busk and Serlin's (1992) d, were also calculated to examine treatment effects and generalisation to untrained items. Effect sizes are interpreted following benchmarks established by Robey and Beeson (2005): 4.0, 7.0, and 10.1 for small, medium, and large, respectively. A weighted d was also calculated to indicate the treatment effect for each participant. A limitation to the Busk and Serlin d statistic is that it cannot be calculated when there is no variance in the baseline phase; thus for P2's List 1, d was not calculated.

Participant 1

After baselining all lists, training for List 1 began and P1 improved her oral naming for the trained items from a low of 20% to 60% accuracy at the end of treatment, $C = .682$, $z = 2.667$, $p < .01$. Similar results were found with the next two treated lists. That is, for List 2, P1's accuracy improved from a low of 0% to 90%, $C = .895$, $z = 3.386$, $p < .01$, and for List 3 her accuracy improved from a low of 0% to 80%, $C = .487$, $z = 1.905$, $p < .05$. Although she did not maintain treatment-level accuracy for any of the treated lists, the trend from baseline to maintenance probing was significant for List 1, $C = .590$, $z = 1.829$, $p < .05$. Yet treatment effects yielded small effects sizes for all lists (List 1: $d = 4.19$, List 2: $d = 1.52$, List 3: $d = 2.21$). The weighted d also yielded a small effect size, $d = 2.50$. Finally, P1 did not demonstrate generalisation to untrained words; accuracy ranged from 10% to 30%. A small effect size was also found for generalisation, $d = 2.50$.

Participant 2

After baselining all lists, treatment for List 1 began. She improved oral naming for the treated items from 30% to 60% accuracy, $C = .632$, $z = 2.471$, $p < .01$. Not only

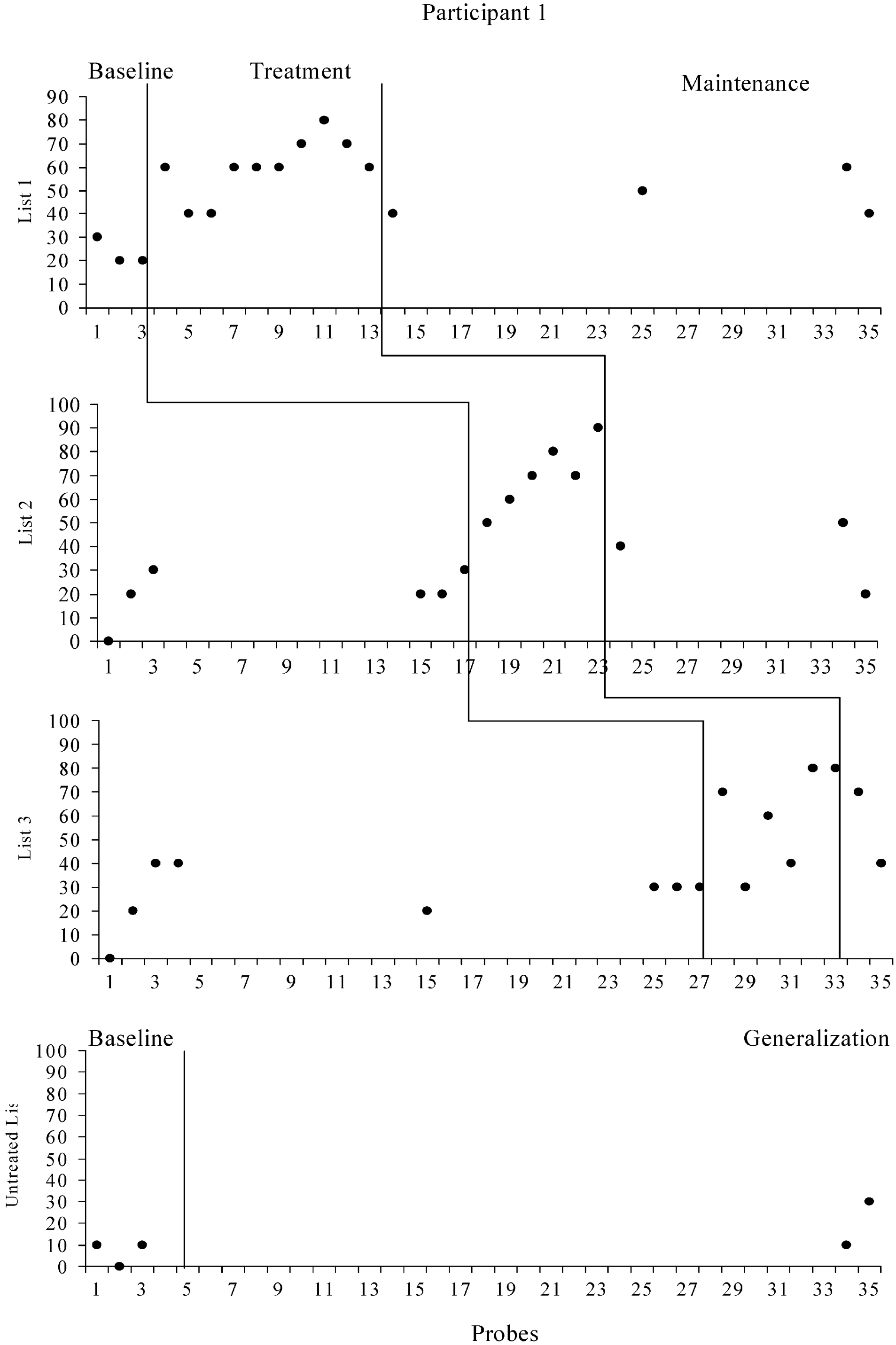

Figure 1. Naming accuracy for Lists 1–3 and the untreated list across baseline, treatment, and follow-up sessions for Participant 1.

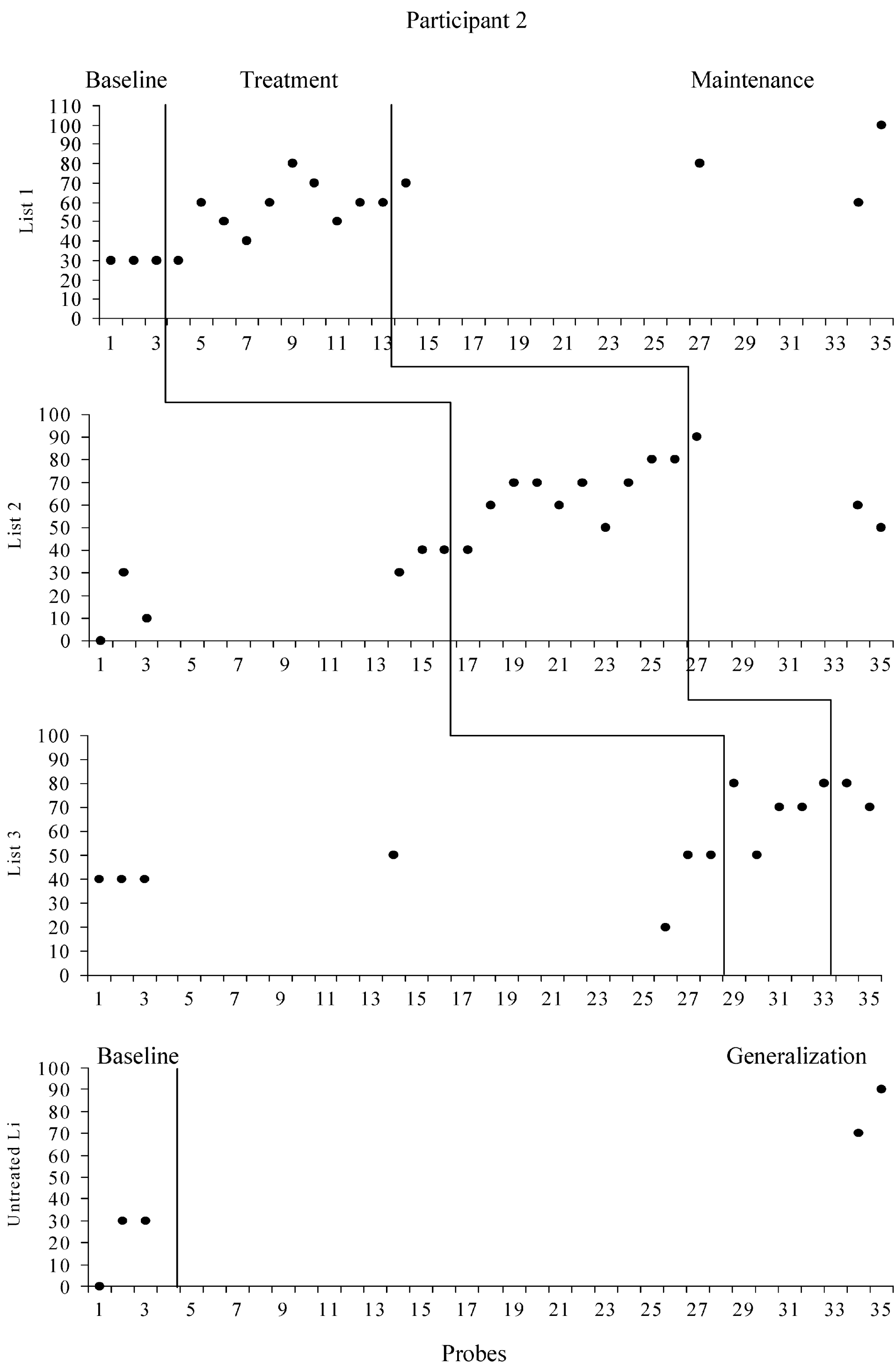

Figure 2. Naming accuracy for Lists 1–3 and the untreated list across baseline, treatment, and follow-up sessions for Participant 2.

did she maintain treatment-level accuracy but she continued to improve her accuracy (60% to 100%), thus the trend from baseline to maintenance probing was significant, $C = .609$, $z = 1.889$, $p < .05$. Similar results were found for treated Lists 2 and 3. For List 2, P2's oral naming accuracy improved from a low of 0% to 80%, $C = .806$, $z = 3.443$, $p < .01$, and she maintained her naming accuracy above baseline levels, $C = .534$, $z = 1.805$, $p < .05$. P2's oral naming accuracy for List 3 improved from a low of 20% to 80%, $C = .507$, $z = 1.852$, $p < .05$ and she maintained treatment level accuracy when probed, $C = .537$, $z = 1.742$, $p < .05$. However, noting a downward trend with maintenance probing suggests that significance of the maintenance effect may have disappeared with additional data points. Finally, she demonstrated generalisation to untrained words (0% to 90%). Treatment effects yielded small effects sizes for Lists 2 and 3, $d = 2.74$ and $d = 3.46$, respectively, with the weighted d also yielding a small effect, $d = 2.95$. A small effect size was also found for generalisation, $d = 3.18$.

Written cueing hierarchy

P1 and P2 differed in the number of steps of the written cueing hierarchy that they required to verbally name the target words across Lists 1, 2, and 3. P1 required all of the steps 90% of the time for List 1, 88% of the time for List 2, and 75% of the time for List 3. From these results, it appears that P1 improved her writing ability for the target words as treatment progressed. P2, on the other hand, rarely required all of the steps of the written cueing hierarchy; that is, she needed all the steps only 4% of the time for List 1, 10% of the time for List 2, and 12% of the time for List 3.

Post-treatment standardised language testing

The WAB and BNT were re-administered during the maintenance session, which occurred 4 weeks after treatment ended. During test development, Kertesz (2006) reported that WAB AQ test–retest variability for individuals with chronic aphasia was .12; mean changes for WAB subtests were also less than one point, suggesting changes greater than these may be considered meaningful. For the BNT, Goodglass et al. (2001) state that "most aphasic patients will repeat earlier performance fairly closely on retest" (p. 16); however, test–retest variability data are not provided to indicate what the mean change is in adults with chronic aphasia, thus limiting interpretation of meaningful change following treatment.

P1's performance fluctuated from pre- to post-treatment across the measures. Her pre-treatment aphasia quotient (AQ) was 61.2 and improved to 64.3 at post-treatment. P1's score on the WAB auditory comprehension section increased from 7.2 to 7.95. No change was found on the fluency or naming sections; however, her performance on the repetition subtest decreased slightly from 3.8 to 3.6. For the BNT, P1's performance declined slightly; naming accuracy decreased from 6 to 3.

P2 improved on all measures from pre-treatment to post-treatment. Her WAB AQ increased from 56.3 to 66.0, indicating an increase in language function following treatment. This improved performance was reflected across the auditory comprehension (7.35 to 7.7), fluency (6 to 7), and repetition (2.6 to 4.4) sections. P2's naming score slightly declined from pre-treatment (5.2) to post-treatment (4.9). However, P2's naming ability on the BNT improved from 2 to 7 (see Table 3).

TABLE 3
Participants' pre- and post-treatment results on the language measures

	P1		*P2*	
	Pre	*Post*	*Pre*	*Post*
WAB[1]				
Fluency	8.0	8.0	6.0	7.0
Auditory Comprehension	7.2	7.95	7.35	7.7
Repetition	3.8	3.6	2.6	4.4
Naming	3.6	3.6	5.2	4.9
Aphasia Quotient	61.2	64.3	56.3	66.0
BNT[2]	6.0	3.0	2.0	7.0

[1]Western Aphasia Battery; [2]Boston Naming Test.

DISCUSSION

The present study examined the effects of a written cueing treatment on verbal naming ability with two adults with conduction aphasia. A single subject modified multiple probe across behaviours design was used and replicated across the two participants. The design included pre-treatment and post-treatment probes as well as a 1-month follow-up probe. Both participants improved their verbal naming abilities for the targeted items during the treatment condition but reflected differences in their response to the treatment. On two of the three treated lists, P1 only required six trials to meet the set performance criterion level of 80% accuracy for two trials. P2, however, required 10 trials on two lists and met performance criterion level for two lists. Possibly, if treatment had continued past 10 sessions, the participants would have reached the 80% performance criterion for all lists. P2 maintained verbal naming performance on the follow-up probe and evinced generalisation (improved naming) on untrained items. P1 maintained gains on verbal naming abilities for only one of three treated lists without any generalisation noted.

Results support and extend previous findings that treating in one output modality improves performance in a different output modality (e.g., Beeson et al., 2002; Beeson et al., 2003; Hillis, 1998; Kiran, 2005). However, the two participants in this study responded differently to the written cueing hierarchy. This suggests that they may have had different underlying problems that were responsible for their deficits. In this respect, findings of the study are similar to those from an earlier report from Hillis (1989).

Although P1 and P2 improved verbal naming when treated with a written cueing hierarchy, they responded very differently to the treatment. A partial explanation for these differences in responsivity is provided by Beeson and colleagues (2002). These authors hypothesised that there are two output links from semantic memory—graphemic output lexicon for the written form and phonological output lexicon for the verbal form. There are also two direct input links to semantic memory—phonological input and graphemic input. If the person is producing the written form of a word from verbal presentation, the pathway is phonological input, then semantic memory to attach meaning to the verbal form, and then graphemic output. For example, the participant hears the word "sun". Next, the semantic memory assigns the concept of "sun", for example, "big, warm, yellow, …". Then, the individual accesses the graphemic output lexicon, the abstract graphemic information is converted into allographs, and the word "sun" is written. If the link between semantic memory and graphemic output is disrupted, the individual will not be able to accurately write the word. If this is the case, then using writing to improve verbal naming accuracy will not be appropriate. If, however, the link between semantic memory and graphemic output is preserved, then writing may serve as an alternative means for word retrieval—as intended in the current study. The participants did demonstrate preserved semantic memory based on their performance on the WAB auditory comprehension subtests. We suggest that they also demonstrated preserved graphemic output ability because they were able to participate in the treatment task. However, because no formal testing of the graphemic output system (i.e., copying tasks) was performed during initial testing, this is only speculative. The pathway would be as follows: graphemic input; semantic memory; then phonological output and verbal production of the target word.

Based on P1's writing difficulties, as demonstrated by her needing all the cueing hierarchy steps most of the time during treatment, possibly there was a disconnection between semantic memory and graphemic output. P1's performance on the RCBA-2 subtests suggests that the graphemic input/semantic memory connection was preserved at the single-word level. However, her difficulty with graphemic output may indicate that this was not the best treatment for her; thus the lack of durability of treatment effects. Further information regarding the integrity of P1's semantic memory, graphemic systems, and phonological systems are needed to more conclusively identify a potential disconnection.

For P2 it initially appears that the graphemic pathway is preserved. Of note, P2 used writing as a verbal word retrieval cueing strategy prior to treatment. Using a written cueing treatment to improve verbal naming may have further strengthened this alternative pathway to the phonological output form. Nevertheless, P2 did not reach the performance criterion for all lists, suggesting that the semantic memory/graphemic output link may not be as well preserved as previously thought.

P1 maintained above-baseline levels 4 weeks after treatment ended for List 1 only, whereas P2 maintained above-baseline levels for all lists. However, small treatment effect sizes were found, suggesting that, even though results were statistically significant, the maintenance levels did not result in meaningful change. One explanation for the results may be participants' performance variability. That is, variability during baseline and maintenance conditions likely limited the ability to find robust, meaningful results. Maintenance of treatment effects for verbal naming after receiving written naming treatment has been mixed. For example, Hillis (1989) reported maintenance data for one participant who maintained verbal and written naming abilities above baseline levels for treated and untreated words nine sessions after treatment ended; however the other participant did not. Although maintenance was reported, it is unclear how long in days, weeks, or months the participant was able to maintain the treatment effects. DeDe et al. (2003) assessed maintenance 6 weeks after treatment ended; their participant lost some treatment gains but still maintained above-baseline accuracy levels. DeDe et al's participant successfully named items that he was able to write during the maintenance session; suggesting that written naming performance influenced verbal naming ability. Possibly, then, P2's strength in written naming contributed to her ability to maintain verbal naming ability for the treated items but not at performance criterion levels.

Ability to generalise to untrained items differed across participants as well. P2 demonstrated generalisation to the untrained list, whereas P1 did not. Hillis (1998) had similar results with one participant generalising to untrained items and the other not. She attributed these different results to differences in the participants' underlying deficits. Based on the differences in writing ability and responsiveness to the treatment, our participants may have presented with different underlying deficits as well. A recommendation for future investigations is to perform pre-treatment language analyses to assess the integrity of participants' semantic memory as well as graphemic and phonological systems. This may shed light on underlying deficits that could account for participants' performance.

An alternative account for why participants evidenced different generalisation effects may be the relatedness of the trained and untrained items. Hillis (1989) reported that one participant demonstrated increased naming accuracy for untrained items that were semantically related to the trained items. Others have reported similar findings (e.g., Kiran & Thompson, 2003). DeDe et al. (2003) also suggested that adding a semantic component that is verbally presented to a written naming treatment would improve generalisation to untrained items that are semantically related to trained items. Possibly a related attribute between trained and untrained items may have contributed to P2's generalisation; however, a definitive explanation is beyond the scope of this paper. Future studies should include untrained items selected a priori that are orthographically, phonologically, and semantically related to the treated items to further investigate this claim.

Conclusions and implications

Despite the limitations of having only two participants, the clinical implications are promising. Results support previous research demonstrating that treating in one modality may benefit performance in another (Beeson et al., 1999, 2002, 2003; Kiran, 2005). Beeson et al. (2003) suggested that combining verbal repetition with CART may stimulate oral language as well as written language abilities. This suggestion was implemented in the current study, and results support this hypothesis that combining verbal cues with a written naming treatment approach may stimulate oral language as well as written language abilities.

Future investigations are warranted to evaluate the effects of using one language modality to facilitate performance in another. Although our results are promising and extend previous findings, they did not evince meaningful change; several issues need to be considered and possibly manipulated in subsequent studies. Personally relevant stimuli should be used to determine if participants perform differently in treatment, as well as generalising to untrained items and maintaining treatment effects following treatment. A writing component should be included during generalisation and maintenance probing to determine if the written cueing hierarchy affected writing ability. Also, future studies should determine if writing treatment changes the nature of participants' verbal responses. For example, this may be determined by calculating the number of phonemes produced in the correct order, rather than simply counting the participants' verbal responses as correct or incorrect. Finally, untreated words that are orthographically, phonologically, and semantically related to the treated words should be included to more comprehensively evaluate generalisation effects.

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REFERENCES

Beeson, P. M. (1999). Treating acquired writing impairment: Strengthening graphemic representations. *Aphasiology*, *13*(9–11), 767–785.

Beeson, P. M., Hirsch, F. M., & Rewega, M. A. (2002). Successful single-word writing treatment: Experimental analyses of four cases. *Aphasiology*, 16(4/5/6), 473–491.

Beeson, P. M., Rising, K., & Volk, J. (2003). Writing treatment for severe aphasia: Who benefits? *Journal of Speech, Language, and Hearing Research*, *46*(5), 1038–1060.

Busk, P. L., & Serlin, R. (1992). Meta-analysis for single case research. In T. R. Kratochwill & J. R. Levin (Eds.), *Single-case research design and analysis: New directions for psychology and education*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Caplan, D. (1992). *Language: Structure, processing, and disorders* (pp. 403–401). Cambridge, MA: MIT Press.

Clausen, N. S., & Beeson, P. M. (2003). Conversational use of writing in severe aphasia: A group treatment approach. *Aphasiology*, *17*, 625–644.

DeDe, G., Parris, D., & Waters, G. (2003). Teaching self-cues: A treatment approach for verbal naming. *Aphasiology*, *17*(5), 465–480.

Goodglass, H., Kaplan, E., & Barresi, B. (2001). *Boston Diagnostic Aphasia Examination – Third edition*. Baltimore: Lippincott, Williams & Wilkins.

Hillis, A. E. (1989). Efficacy and generalisation of treatment for aphasic naming errors. *Archives of Physical Medicine and Rehabilitation*, *70*(8), 632–636.

Kertesz, A. (1982). *The Western Aphasia Battery*. New York: Grune & Stratton.

Kiran, S. (2005). Training phoneme to grapheme conversion for patients with written and oral production deficits: A model-based approach. *Aphasiology*, *19*, 53–76.

Kiran, S., & Thompson, C. K. (2003). The role of semantic complexity in treatment of naming deficits: Training semantic categories in fluent aphasia by controlling exemplar typicality. *Journal of Speech, Language, and Hearing Research*, *46*, 608–622.

Kucera, H., & Francis, W. N. (1967). *Computational analysis of present day American English*. Providence, RI: Brown University Press.

LaPointe, L., & Horner, J. (1998). *Reading Comprehension Battery for Aphasia – Second edition*. Austin, TX: Pro-Ed.

Lustig, A. P., & Tompkins, C. A. (2002). A written communication strategy for a speaker with aphasia and apraxia of speech: Treatment outcomes and social validity. *Aphasiology*, *16*(4/5/6), 507–521.

Pedersen, P. M., Vinter, K., & Olsen, T. S. (2001). Improvement of oral naming by unsupervised computerized rehabilitation. *Aphasiology*, *15*, 151–169.

Robey, R. R., & Beeson, P. M. (2005). *Aphasia treatment: Examining the evidence*. Presentation at American-Speech-Language-Hearing Association Convention, San Diego, CA.

Snodgrass, D. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory*, *6*(2), 174–215.

Suen, H. K., & Ary, D. (1989). *Analyzing quantitative behavioral observation data*. Hillsdale, NJ: Lawrence Erlbaum & Associates Inc.

Tripodi, T. (1994). *A primer on single-subject design for clinical social workers*. Washington, DC: NASW Press.

Tryon, W. W. (1982). A simplified time-series analysis for evaluating treatment interventions. *Journal of Applied Behavior Analysis*, *15*, 423–429.

APPENDIX

Word lists for each participant

P1 Word lists
- List 1: bottle, bell, carrot, celery, barn, strawberry, purse, saw, scissors, elephant
- List 2: bow, onion, lemon, leaf, bird, bee, butterfly, bear, pants, shoe
- List 3: turtle, hen, tree, sun, pineapple, TV, cake, glasses, monkey, leg
- Untreated list: helicopter, flag, ostrich, windmill, swan, drum, kite, wheel, cherry, sea horse

P2 Word lists
- List 1: plug, pear, pumpkin, falcon, fish, finger, sandwich, button, comb, box
- List 2: flower, bed, fence, fork, hanger, clothespin, penguin, arrow, pepper, toe
- List 3: mushroom, nail, screwdriver, arm, fox, telephone, beads, orange, football, glove
- Untreated list: camel, key, lamp, iron, belt, hand, table, asparagus, basket, ring