2006

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Original Publication Citation

Raymer, A., & Kohen, F. (2006). Word-retrieval treatment in aphasia: Effects of sentence context. *Journal of Rehabilitation Research and Development, 43*(3), 367-377. doi:10.1682/jrrd.2005.01.0028

Department of Veterans Affairs

JRRD Volume 43, Number 3, Pages 367–378
May/June 2006
Journal of Rehabilitation Research & Development

Word-retrieval treatment in aphasia: Effects of sentence context

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Abstract—Word-retrieval treatment studies in aphasia have reported the greatest influences on picture naming for trained words. To increase treatment effects to untrained words and sentence contexts, we investigated a sentence-reading treatment hierarchy that moves from errorless to generative production of sentences incorporating target nouns and verbs. In an individual with nonfluent aphasia, treatment resulted in improved picture naming for nouns and verbs and generalized increases in numbers of grammatical sentences and content words following noun therapy. A second individual with fluent aphasia improved little in picture-naming and sentence-generation tasks for both nouns and verbs. This sentence-based word-retrieval training, in which semantic and syntactic processes are engaged, led to improvements in word-retrieval measures during spontaneous sentence generation, but only for the participant with nonfluent aphasia. Contrary to expectations, these changes were greater following noun therapy than they were following verb therapy.

Key words: accident, anomia, aphasia, Broca's aphasia, cerebrovascular, grammar, language, nouns, rehabilitation, speech therapy, verbs.

INTRODUCTION

One of the most common signs associated with left-hemisphere injury and aphasia is anomia, the inability to retrieve intended words during conversation or in structured language tasks, such as naming pictures to confrontation [1]. Many investigations of word retrieval have focused on nouns [2–3], including several that indicate that left posterior (especially temporal) lesions are associated with noun-retrieval impairments [4–5]. More recent research has described verb-retrieval disorders in individuals with aphasia [6], particularly in association with left inferior frontal lesions [5,7].

In addition to the finding that different anatomic regions appear to be critical for recalling nouns and verbs, these regions also differ in important linguistic dimensions, particularly during sentence production. Verbs are viewed as the critical element upon which sentence construction proceeds. Specifically, the verb determines the argument structure of a sentence, that is, the number of nouns required to form a grammatical sentence. For example, selection of the verb "swim" requires the sentence to include a subject (animate object) doing the swimming (e.g., The *girl* swims.). When the verb "push" is embedded in a sentence, it requires both a subject doing the pushing and a recipient of the pushing

Abbreviations: ANT = Action Naming Test, AQ = Aphasia Quotient, BNT = Boston Naming Test, CT = computed tomography, CVA = cerebrovascular accident, *df* = degrees of freedom, NS = not significant, NV = noun/verb, RCBA = Reading Comprehension Battery for Aphasia, WAB = Western Aphasia Battery.

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DOI: 10.1682/JRRD.2005.01.0028

action (e.g., The *girl* pushes the *swing*.). Therefore, noun selection partly depends on verb selection. The verb's argument structure influences how easily it is retrieved [8]. In the case of verb-retrieval failure, the whole process of sentence formulation can be undermined [9–10]. Although nouns and verbs have important differences, many individuals with aphasia demonstrate impairments in both noun and verb retrieval [9]. Even mild word-retrieval impairments can be detrimental to effective verbal communication and compromise vocational and social communication skills. Thus, identifying successful treatments to reduce the disability and suffering associated with this debilitating disorder is necessary.

Investigators have reported the effects of several different methods for treating word-retrieval impairments in aphasia [11–12]. Treatment studies have largely incorporated training for noun-retrieval impairments, although several recent studies also have addressed verb-retrieval impairments [13]. Some treatments attempt to restore abilities by placing patients in an enriched linguistic environment designed to reactivate or relearn in a manner compatible with the normal processes engaged in word retrieval [14]. Thus, patients participate in lexical activities in which semantic (meaning) and/or phonologic (sound) attributes of words are activated in picture naming, word/picture matching, answering questions, and other lexical tasks. Several studies examining noun or verb retrieval have reported that, over time, patients who participate in semantic or phonologic training improve their ability to retrieve the names of trained pictures, particularly when both semantic and phonologic information is activated in the course of training [15].

Although substantial literature can be found on word-retrieval treatments, some overriding limitations exist across studies. A key goal of treatment is promoting generalized improvements in word-retrieval abilities for all words in contexts beyond the training setting. Whereas occasional studies have reported generalized effects of word-retrieval training [16–17], the majority of studies have reported largely item-specific training effects [11]. That is, patients improve their ability to name pictures corresponding to words practiced in the training, but gains are limited for untrained words or in standardized word-retrieval tests. One may argue that limited generalization may be expected, given our understanding of the cognitive mechanisms of word retrieval. Semantic and lexical-phonological stages engaged in word retrieval comprise stored representations for previously learned words, represented as patterns of activity distributed across a network of nodes and where knowledge is stored in the strength of the nodal interconnections [18–19]. Word-retrieval training, in effect, may be influencing the weighting of interconnections, affecting only the targeted nodal networks and not all lexical nodes. Words with overlapping interconnections might be enhanced in training [17], but not word-retrieval abilities in general. In fact, the contextual effects spreading through a distributed network may possibly interfere with retrieving other related words [20].

One modification that may enhance the impact of word-retrieval training is placing training in an enriched linguistic context. Specifically, evidence suggests that word retrieval during picture naming, the task used in the majority of treatment studies, may be accomplished through the direct activation of visual object-to-phonological representations, bypassing full conceptual-semantic activation [21–22]. During conversational word retrieval, in contrast, phonological representations are engaged via networks of semantic and grammatical nodes that play critical roles in activation of appropriate words to express an intended message in a sentence context [23]. Visual object-phonological networks are less relevant in conversational word retrieval. Furthermore, verb retrieval in the sentence context requires the engagement of the verb argument structure, which is not activated in isolated verb picture naming. Several studies have shown that success for noun or verb retrieval can vary depending on the elicitation context, pictures versus sentences [8,24–25].

Several studies report the effects of training with activities that engage syntactic information and not simply picture naming [26]. These tasks include generation of verbs within a given sentence frame [27–28] and production of sentences using verbs with constrained argument structures [12,29]. Whereas verb retrieval during picture naming improves sentence production in only some cases [13], verb training within sentence-like contexts leads to improvements in both picture naming and sentence production in all studies examined [26]. However, the effects of a sentence-context for training noun retrieval have not been systematically examined. Maher and Raymer noted, as a by-product of training focused on production of grammatical sentences, that patients demonstrated improvements in noun retrieval and not verb retrieval [30]. In the current study, we systematically explored the effects of word-retrieval training in a sentence context for both nouns and verbs.

In addition to placing word-retrieval training within a sentence context, the specific methods implemented may influence training effects. Two contrasting principles, errorless learning and self-generation, have been investigated for their effects in training individuals with brain damage. In errorless learning, emphasis is placed on avoidance of error production during training for a given behavior. Errorless training methods have been reported superior to errorful ones in improving performance in memory tasks in some brain-damaged participants [31–32]. In aphasia treatment, few methods have been completely errorless, but Fillingham et al. reported that error-reducing methods were as effective as errorful methods for improving word retrieval [33].

In contrast to errorless learning is the concept of self-generation. Several studies have shown that individuals remember information better when they are required to self-generate responses than when they are provided answers [34]. The generation effect has been associated with improved memory performance in some brain-damaged individuals as well [35]. Tailby and Haslam considered both errorless learning and self-generation in their study of memory for word lists in a group of brain-injured participants [36]. They found that participants remembered words best in a condition that provided maximum cues for self-generation followed by writing of the correct word (errorless component), that is, when elements of errorless learning and self-generation were integrated in the training protocol. The word-retrieval training implemented in this study incorporated the concepts of errorless learning and self-generation into the training protocol as a hierarchy of steps moving from errorless production toward self-generation of verbal responses.

This study evaluates the effects of a training protocol devised to incorporate the principles of sentence context-embedded production, errorless learning, and the generation effect for noun and verb retrieval. We report the patterns of results from two individuals with contrasting forms of aphasia.

METHODS

Participants

Participant 1 was an 80-year-old right-handed male who was 5 years postonset of a left-hemisphere cerebrovascular accident (CVA) resulting in fluent aphasia. A computed tomography (CT) scan performed 3 years later revealed a left temporal-parietal lesion. Participant 2 was a 69-year-old right-handed male who was 6 years postonset of a left CVA leading to nonfluent aphasia. A CT scan at the time of onset showed a lesion affecting left frontal subcortical white matter. Both were administered a battery of aphasia tests at the initiation of this experiment, including the Western Aphasia Battery (WAB) [37], Boston Naming Test (BNT) [38], the Action Naming Test (ANT) [39], portions of the Reading Comprehension Battery for Aphasia (RCBA) [40], and a Noun/Verb (NV) Lexical Battery [7]. The lexical tasks incorporated 30 verbs and 60 nouns, 30 nouns matched to the base frequency of the verbs (e.g., run), and 30 nouns matched to the cumulative frequency of the verbs (e.g., run + runs + running). In NV picture naming, participants viewed black and white line drawings and named the object or action (What is happening? What is he/she doing?). In NV sentence completion, the examiner read aloud a sentence as the participant read along and filled in the final missing word (e.g., Wherever mother duck goes, the baby ducks will . . . *follow.*). A correct response in the picture naming and sentence completion tasks was the target word or an alternative word observed in normative studies. In the third task, NV word/picture verification, the participant decided whether a spoken word corresponded to a target picture. In half the trials, the spoken word was the correct target word ("yes"), and in the other half, the spoken word was an associated foil word ("no," e.g., picture-follow, foil-lead). To be scored as correct, the participant must respond correctly for both "yes" and "no" trials. Results of all tests are shown in **Table 1**.

Participant 1 presented with a moderately severe fluent aphasia consistent with the pattern of Wernickes aphasia. He also had significant difficulty in reading comprehension subtests. On the naming tests, he demonstrated severe anomia with numerous circumlocutions and semantic paraphasia. He had more difficulty naming nouns than verbs on the NV picture naming task (χ^2 = 7.75, degree of freedom [*df*] = 1, $p < 0.01$), although no significant difference existed in other NV comparisons (sentence completion: χ^2 = 3.14, *df* = 1, not significant [NS]; word/picture verification: χ^2 = 3.33, *df* = 1, NS). Performance was impaired relative to normal controls across naming and verification tasks, suggesting that noun- and verb-retrieval deficits might be attributed to semantic failure.

Table 1.
Pre- and posttreatment test results for two participants with aphasia.

Test	Participant 1		Participant 2	
	Pretest	Posttest	Pretest	Posttest
WAB AQ (maximum 100)	54.2	61.3	77.6	82.6
Fluency (maximum 10)	6.0	8.0	4.0	6.0
Comprehension (maximum 10)	5.3	6.25	9.5	9.6
Repetition (maximum 10)	4.8	5.4	8.8	8.4
Naming (maximum 10)	4.0	3.0	8.5	8.3
BNT	3/60	2/60	40/60	33/60
ANT	13/62	19/62	33/62	41/62
RCBA Score	29/60	35/60	45/60	57/60
Time (min)	24:00	13:30	15:00	13:00
Noun/Verb Lexical Battery				
Picture Naming				
Nouns (*n* = 60)	26.7%	—	65.0%	—
Verbs (*n* = 30)	56.7%	—	56.7%	—
Sentence Completion				
Nouns (*n* = 60)	26.7%	—	66.7%	—
Verbs (*n* = 30)	43.3%	—	56.7%	—
Word/Picture Verification				
Nouns (*n* = 60)	46.7%	—	71.7%	—
Verbs (*n* = 30)	26.7%	—	56.7%	—

Note: Impairment for both participants was semantic at pretest.
ANT = Action Naming Test, BNT = Boston Naming Test, RCBA = Reading Comprehension Battery for Aphasia, WAB AQ = Western Aphasia Battery aphasia quotient.

Participant 2, in contrast, demonstrated nonfluent transcortical motor aphasia with moderate apraxia of speech. He had moderate reading comprehension difficulties. His word-retrieval impairment fell in the mild-to-moderate range, and his errors consisted of semantic paraphasias for both nouns and verbs. While somewhat worse for verbs than for nouns, these differences did not reach significance in any of the NV comparisons (Picture Naming: χ^2 = 0.59, *df* = 1, NS; Sentence Completion: χ^2 = 0.86, *df* = 1, NS; Word/Picture Verification: χ^2 = 2.03, *df* = 1, NS). Like participant 1, participant 2's performance was impaired relative to normal controls across naming and verification tasks, suggesting that noun- and verb-retrieval deficits might be attributed to semantic failure, although participant 2's impairment was overall milder than that of participant 1 for both nouns and verbs. Both participants provided written informed consent to participate in a study of word-retrieval treatment that was approved by the Old Dominion University Institutional Review Board, Norfolk, Virginia.

Treatment Design and Materials

The study incorporated a single-participant time series design across participants and behaviors [41]. Several daily probe tasks and pre- and posttest measures were administered to both participants. The primary daily probe task was word retrieval in response to transitive action pictures (e.g., a boy walking a dog). The clinician pointed to the action or object in the picture and asked "What is he doing?" or "What is this?" From an original set of 150 transitive action pictures, we selected 60 pictures corresponding to 30 nouns and 30 verbs that each participant had difficulty retrieving in two baseline measures. Sets of 20 nouns and 20 verbs were used for training words. The remaining 10 nouns and 10 verbs were used for untrained generalization probes. Trained and untrained lists were balanced such that naming accuracy was less than 25 percent correct for the sets of trained and untrained stimuli across baseline sessions. Probe words are noted in italics in the sentence list in the **Appendix** (available online only at http://www.rehab.research.va.gov). A control daily probe task involved reading 20 multisyllabic adjectives. Responses were scored online by the examiner, and subsets of probe sessions were recorded for later reliability analyses by a second examiner. The dependent variable in the picture-naming and oral-reading tasks was percent correct production of target words.

We administered the probe tasks for three to four sessions to establish stable baseline performance before initiating the two treatment phases. In the therapy phases, we began each session with naming and oral word reading probes to evaluate treatment effects prior to administration of the treatment protocol. After a 1-month break between therapy phases, we administered probes to assess maintenance of therapy results. During phase 1 therapy for verbs, participant 2 demonstrated generalized improvements for untrained nouns; thus, we identified a new set of 30 nouns (20 trained and 10 untrained) to be implemented in phase 2 therapy. Performance for the new sets of nouns was stable and low (<25% correct) across baseline sessions.

All daily probe results were graphed and analyzed with three separate measures of change. Improvements were assessed with Tryon's *C* statistic, a statistical analysis method sensitive to changes in performance within a time series study [42]. If performance improves over sessions, scores are more greatly dispersed compared with the mean level of performance for that phase, resulting in an increased *z* score. Recognizing that the *C* statistic is not without its limitations [43], we also assessed effect sizes and gain scores in each treatment phase. Effect sizes (*d*) were calculated, comparing the mean performance in the final four sessions of treatment to the baseline mean performance relative to the baseline standard deviation [44]. Effect sizes of $d > 2.5$ were considered large. Finally, gain in performance of >20 percent was considered meaningful comparing baseline with the final four treatment sessions. As a more conservative metric of meaningful treatment effect, we considered significant only those results that indicated a meaningful gain (>20%), a significant *C*-statistic value, and an effect size of $d > 2.5$.

Other outcome measures were administered at pre- and posttreatment phases of the experiment. To assess generalization of word retrieval to other contexts, we administered a sentence-production task. For each action picture used in daily naming probes, the participant attempted to produce a complete sentence. Sentences were transcribed online by the examiner, and subsets of sentences were video-recorded for later reliability analyses completed by a second examiner. Sentences were scored for grammaticality of the utterance (i.e., a complete sentence with all grammatical elements present), presence of the target noun or verb within the sentence, and number of content words used in each sentence (i.e., nouns, verbs, adjectives, adverbs). Pre- and posttreatment results were analyzed with paired samples statistics (*t*-tests for content words, McNemar's χ^2 test for grammaticality and presence of target words). Finally, at the completion of treatment, we readministered several standardized aphasia tests (WAB, BNT, ANT, and RCBA).

Treatment Protocol

Treatment involved a sentence-embedded word-retrieval training protocol using action pictures paired with oral reading of corresponding sentences. Sentences were constructed such that no target words overlapped across the noun and verb phases of training. All treatment sentences with probe words in italics are listed in the **Appendix** (available online only at http://www.rehab.research.va.gov). The treatment involved steps to elicit a target noun or verb produced within a sentence for each action picture (e.g., She is wrapping a *present*; He is *walking* the dog.). To include an errorless component in training, the clinician first modeled the target sentence and the participant then read aloud the corresponding sentence, receiving prompts as needed to correctly pronounce each word. Moving in the direction of self-generation of utterances in subsequent steps, the clinician first covered the target noun or verb and then the full sentence, and the participant had to generate the full sentence corresponding to the picture, including any covered word(s). Following practice with production of all 20 sentences, treatment concluded with a barrier activity to encourage spontaneous production of target words. The participant selected a training picture hidden from the clinician's view and had to say the name of the target word or an associated sentence until the clinician identified the target picture. Training was provided for 20 words and continued in two phases, nouns versus verbs, in counterbalanced order for the two participants as determined in a random drawing. Participant 1 trained first for nouns and then for verbs. Participant 2 trained first for verbs and then for nouns. Finally, participants were given the 20 target sentences/pictures along with an audiotape to practice at home. Participants were seen for two 1 h sessions a week with daily homework practice on trained sentences/pictures. The treatment ended when performance reached 90 percent accuracy in 3 sessions to a maximum of 10 treatment sessions.

Reliability

One examiner transcribed online and scored all responses. A second examiner coded all taped samples to allow calculation of scoring reliability, as well as reliability on administration of the treatment protocol. Agreement reliability on the daily probe picture-naming measures, calculated for 10 percent of sessions, ranged 96.7 to 100 percent across sessions (mean 98.4%). Reliability on transcription of sentences for 25 percent of the samples indicated complete agreement for 96.7 percent of sentences. Finally, reliability on the independent measure calculated for 10 percent of sessions indicated that 99.1 percent of the steps of the protocol were instituted as planned across the samples. All these calculations indicate high levels of reliability on scoring and treatment administration.

RESULTS

Results for participant 1 are shown in **Figure 1** and **Tables 2** and **3**. Baseline levels of performance for naming and oral reading were low and stable across three sessions. In phase 1, participant 1 participated in training for noun targets. A minimal gain in picture-naming performance was evident for trained nouns. Because of very low baseline scores, these minor changes led to significant findings for *z* score and effect size (*d*) measures. Likewise, gain scores were minimal, yet *z* score and effect size results were significant for untrained verbs and oral word reading. That is, although changes were evident on some measures, application of the conservative metric of meaningful improvements in all three measures suggests no significant increases for picture naming following noun-retrieval training. Results for sentence production for action pictures (**Table 3**) indicated that participant 1 had no changes evident for trained noun pictures or for untrained noun and verb pictures in numbers of target words used, numbers of grammatical sentences produced, and in mean number of content words per sentence. No significant change was evident in numbers of grammatical sentences across sets of stimuli as participant 1 performed near ceiling levels prior to training, particularly for the noun pictures.

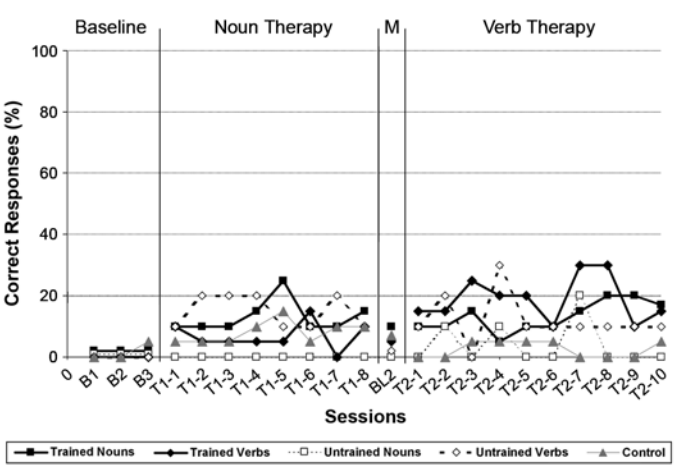

Figure 1.
Number of correct responses in picture naming and oral reading for participant 1. B = baseline session, BL = maintenance (M) baseline session, T1 = noun therapy session, T2 = verb therapy session.

In phase 2, during which participant 1 participated in verb therapy, he showed increases in *C* statistic or effect sizes, but on no set of words (trained verbs, untrained verbs and nouns) did he demonstrate significant improvements across all three measures of change. Performance for the oral reading task actually declined during this training phase. Likewise in the sentence-production task, participant 1 again demonstrated no significant increases in use of grammatical sentences, target words within sentences, or mean number of content words per sentence. At the completion of two phases of training, participant 1's performance had improved in some standardized tests scores, however (**Table 1**). Increases on the WAB Aphasia Quotient (AQ) were associated with changes in comprehension and repetition scores following training. Improvement was noted on the ANT, as well as for accuracy and reading time for the RCBA.

Results for participant 2 can be seen in **Figure 2** and **Tables 2** and **3**. He also had a low stable baseline performance across four sessions, particularly for verbs. Participant 2 received verb therapy in phase 1. When training was applied to a set of trained verbs, he demonstrated significantly improved picture naming to as high as 80 percent correct for trained verbs with a significant *z* score and a very large effect size (due to the large gain relative to the stable baseline). That is, improvement was evident on all three measures of treatment change. Participant 2 also significantly improved picture naming for untrained verbs and untrained nouns (i.e., all 30 nouns were untrained in phase 1) as indicated by increases in all

Table 2.
Results of action picture naming and oral reading probes calculated as gain scores from baseline to end of treatment, Tyrone's *C*-statistic *z* scores, and effect sizes (*d*) for noun and verb training phases. (Results considered significant if changes evident in all three measures.)

Test	Participant 1						Participant 2					
	Phase 1 Noun Therapy			Phase 2 Verb Therapy			Phase 1 Verb Therapy			Phase 2 Noun Therapy		
	Gain (%)	*z*	*d*	Gain (%)	*z*	*d*	Gain (%)	*z*	*d*	Gain (%)	*z*	*d*
Trained Nouns	5.0	2.14*	2.63†	5.9	1.58	2.02	—	—	—	85.0‡	3.25§	34.0†
Untrained Nouns	0	0	0	5.0	–1.01	1.32	21.7‡	2.55§	3.55†	30.0‡	1.22	5.45†
Trained Verbs	—	—	—	16.3	1.40	3.25†	63.8‡	3.02§	25.5†	–2.5	0.54	–0.5
Untrained Verbs	9.6	1.99*	3.35†	0	–1.43	0	22.5‡	1.72*	2.84†	14.2	1.89*	1.23
Oral Reading Words	10.0	1.86*	6.06†	–7.1	2.36§	–2.45	15.9	2.03*	5.66†	15.0	2.66§	3.0†

*$p < 0.05$.
†$d > 2.5$.
‡Gain > 20%.
§$p < 0.01$.

Table 3.
Changes in sentence production in number of grammatical sentences (McNemar's χ^2), target words (McNemar's χ^2), and content words (paired samples *t*-tests) from pre- to posttherapy.

Test	Participant 1				Participant 2			
	Noun Therapy		Verb Therapy		Verb Therapy		Noun Therapy	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Trained Nouns								
No. of Grammatical Sentences	15/20	18/20	18/20	15/20	—	—	5/20	18/20*
No. of Target Words	0/20	2/20	1/20	1/20	—	—	2/20	14/20*
Mean No. of Content Words/Sentence	2.35	2.45	2.45	2.2	—	—	1.35	2.85†
Untrained Nouns								
No. of Grammatical Sentences	9/10	9/10	9/10	9/10	5/30	9/30	1/10	6/10
No. of Target Words	0/10	2/10	0/10	0/10	12/10	10/10	0/10	5/10
Mean No. of Content Words/Sentence	2.30	2.90	2.90	2.30	1.7	1.9	1.10	1.90
Trained Verbs								
No. of Grammatical Sentences	—	—	14/20	15/20	7/20	6/20	7/20	18/20*
No. of Target Words	—	—	0/20	0/20	8/20	11/20	12/20	10/20
Mean No. of Content Words/Sentence	—	—	2.75	2.05	1.45	1.85	2.05	2.80*
Untrained Verbs								
No. of Grammatical Sentences	16/30	21/30	6/10	8/10	2/10	0/10	0/10	8/10†
No. of Target Words	4/30	1/30	1/10	1/10	8/10	3/10	4/10	6/10
Mean No. of Content Words/Sentence	2.87	2.70	2.60	2.70	1.60	1.0	0.90	2.50*

*$p < 0.01$, significant change.
†$p < 0.05$, significant change.

three metrics of improvement (**Table 2**). Improvements in oral reading of words, although notable for the *z* score and effect size, were not large when the minimal gain from baseline to posttreatment is considered. In contrast to the significant improvements evident in picture naming, participant 2 demonstrated no significant increases in the sentence-production measures (**Table 3**) during phase 1 verb therapy.

Because improvement occurred for untrained nouns during phase 1, a new set of nouns was identified for phase 2 noun therapy. Performance was stable for these sets across three baseline sessions. When phase 2 therapy began, participant 2 significantly improved his picture naming (*z* score $p < 0.01$) for trained nouns, reaching 90 percent accuracy and resulting in a very large effect size *d*. Although increases were evident in untrained nouns (gain score, effect size), untrained verbs (*z* score), and oral word reading (*z* score), these increases were not consistent across all three metrics of improvement. In contrast to phase 1, significant changes were also evident in

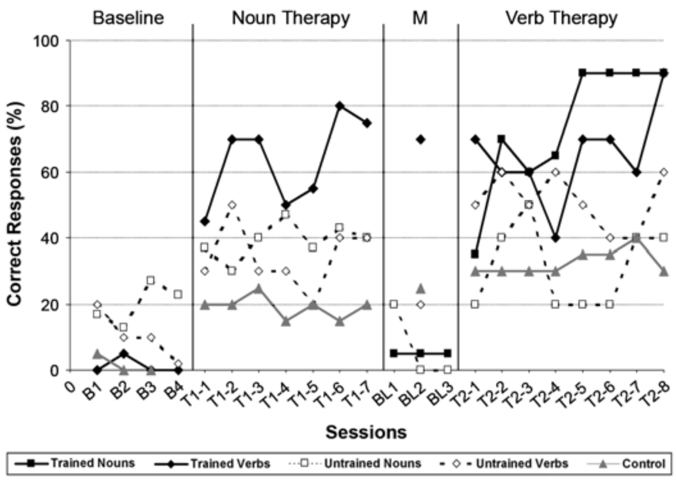

Figure 2.
Number of correct responses in picture naming and oral reading for participant 2. B = baseline session, BL = maintenance (M) baseline session, T1 = noun therapy session, T2 = verb therapy session.

the sentence-production task following phase 2 noun therapy. Participant 2 produced more grammatical sentences for trained nouns (McNemar $p = 0.000$) and for both sets of verbs, one of which had been trained in phase 1 (trained McNemar = 0.001, untrained McNemar = 0.016). He used significantly more target words within in his sentences for trained noun pictures (McNemar = 0.000). Finally, his general use of content words increased for trained nouns ($t = 2.94$, $df = 19$, $p = 0.008$). However, no increases were evident in content word use for untrained nouns ($t = 1.71$, $df = 9$, $p = 0.12$) and verbs ($t = 1.31$, $df = 29$, $p = 0.202$). Like participant 1, at the completion of two phases of therapy, participant 2 improved on standardized language measures (**Table 1**). His WAB AQ increase was, in large part, due to the increase in his fluency score. Like participant 1, participant 2 improved on the ANT and in accuracy and time for completion of the RCBA.

DISCUSSION

Following sentence-based word retrieval training, both participants demonstrated positive effects of treatment, although in different patterns. Participant 1, the individual with fluent aphasia associated with a left posterior lesion, had only minimal treatment effects in the primary picture-naming probe measure and the sentence-production measures. He did, however, demonstrate increases in standardized tests. Caregivers often report improvements following treatment that our measures do not reflect. In the case of participant 1, his wife insisted that he was speaking more at home, despite the fact that our daily picture naming probes showed no change. We might speculate that participant 1 was attempting to respond to her questions and to initiate utterances more often, although the integrity of his productions remained significantly impaired.

Participant 2, the individual with nonfluent aphasia associated with a large anterior subcortical lesion, had very large treatment effects in picture naming for both trained nouns and verbs. He also demonstrated generalized picture-naming improvements for untrained nouns and verbs, but only during phase 1 verb therapy. In contrast, improvements noted during sentence generation were only observed following phase 2 noun therapy. He increased his use of trained words, the overall number of content words, and the number of grammatical sentences he produced. In fact, participant 2's mean number of content words per sentence increased to levels noted for participant 1. Participant 2 improved not only his word retrieval during sentence production, but also his use of complete, grammatical sentences. Admittedly, those sentences were basic active agent-action-object sentence structures, but they were well-formed nonetheless and reflected a definite change compared with pretreatment performance.

Based on our understanding of the process of sentence generation, where the verb dictates selection of noun constituents in a sentence, we predicted greater improvements in the sentence-production measures following verb therapy. Our results do not support this contention. Only participant 2 demonstrated increases in sentence production, and those increases came after the noun therapy, which he received in phase 2. Until the study is replicated in other individuals, we cannot determine whether the cumulative effects of verb and then noun therapy led to the dramatic increases noted for participant 2 following noun therapy in phase 2. That is, amount of training may have been an active component of the phase 2 effects observed. Participant 1 did not seem to show such cumulative effects of treatment, however. Although each training phase focused on one particular target noun or verb, other verbs and nouns were also engaged during the steps of the training hierarchy. Thus, despite the fact we were trying to target a particular grammatical category of words in each training phase, both nouns and verbs, ultimately, were practiced within the sentence production hierarchy. Therefore, the influence of verb therapy for sentence-production was confounded, as verbs also happened to be practiced during noun therapy sentences as well.

Earlier studies using sentence production to promote word retrieval had focused on effects for verbs [26]. This study demonstrated significant improvements for noun retrieval as well, particularly for participant 2, the individual with nonfluent aphasia. Effects of this sentence-embedded training protocol led to generalized improvements for some untrained words and for production of spontaneous sentences. Training led to improvements in standardized measures for both participants. In contrast to Maher and Raymer [30], who reported increases on the BNT following sentence training, both participants in this study showed increases on the ANT, a verb-retrieval measure, and not the BNT.

CONCLUSIONS

In the current study, participant 2, the individual with a grammatical sentence-production impairment, responded better to the sentence-level training than did participant 1, whose impairment was largely one of word retrieval in the context of fairly intact grammatical abilities. These results certainly must be replicated in other individuals with nonfluent forms of aphasia. What we did not specifically contrast in this study are the effects of a sentence-training protocol as compared with the more typical picture-naming training to improve word retrieval. That is, we do not know whether participant 2 would have improved as well in sentence-production measures if he had taken part in a picture-naming treatment protocol. Nor did we systematically examine the importance of the steps in our training protocol that incorporated errorless productions and, later, self-generated productions of sentences. We elected to include both principles within our training protocol. Future studies will need to evaluate the influence of errorless versus self-generated productions for word-retrieval acquisition and retention. These preliminary findings, however, suggest that word-retrieval training completed within a sentence context may be an effective and efficient method for improving generalized word-retrieval abilities for both nouns and verbs in some individuals with aphasia.

ACKNOWLEDGMENTS

We are grateful to our two subjects for their willing participation in this study.

This material was based on work supported by the National Institute on Deafness and Other Communication Disorders, grant P50 DC03888-01A1, to the University of Florida, Gainesville, Florida (subcontract to Old Dominion University, Norfolk, Virginia), and by the Department of Veterans Affairs Rehabilitation Research and Development Center of Excellence, grant F2182C, to the Brain Rehabilitation Research Center, Gainesville, Florida.

The authors have declared that no competing interests exist.

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Submitted for publication January 27, 2005. Accepted in revised form September 26, 2005.