Introduction

Conduction aphasia is characterized by significant changes to language output including phonetically complex paraphasias, severely impaired repetition, and difficulty comprehending specific lexical information in isolation despite relatively good comprehension of the 'gist' of the message (Baldo, Klostermann, & Dronkers, 2008; Goodglass, 1992; Joanette, Keller, & Lecours, 1980; Kohn, 1984). Nickels, Howard, and Best (1997) proposed that individuals with conduction aphasia experience difficulty processing auditory-verbal information secondary to disruption in articulatory loop processes. Baldo et al. (2008), using sentence level stimuli, further suggested that persons with conduction aphasia rely more on the semantic processes versus articulatory loop processes when interpreting messages. Such deficits in conduction aphasia are not exclusive to language output channels (Baldo et al., 2008; Caramazza, Basili, & Koller, 1981; Shallice & Warrington, 1977; Warrington & Shallice, 1969).

In the current study, we combined the work of Nickels et al. (1997) and Baldo et al. (2008) to develop a novel multimodal, combined semantic and a phonological approach for treatment for an individual with chronic conduction aphasia. The goal of this treatment was to improve auditory comprehension (e.g., word and sentence level) and increase propositional spoken language (e.g., single word and discourse level). We hypothesized that priming the semantic network would facilitate access to the phonological representation of trained words and as a result, improved auditory comprehension and lexical retrieval.

Method

Participant.

P1 is a 79-year old right-handed woman who experienced a left-hemisphere ischemic stroke in March 2011. The stroke resulted in a large left hemisphere infarct involving posterior insula, inferior frontal lobe, parietal lobe, and extending into the deeper white matter in the region of these structures. P1 was 18-months post-stroke. P1 completed approximately 28 hours of individual outpatient language therapy and 8 hours of group communication therapy from June 2011 to June 2012. Previous therapy focused predominately on unimodal phonological approaches for lexical retrieval and development and use of a communication board with little noted progress.

Study Design

A single-subject multiple-baseline design was used. Modifications to a strict multiple-baseline design were implemented to accommodate the clinical setting in which the study was conducted.

Baseline and Outcome Measures

A comprehensive battery of aphasia assessments was administered pre-treatment, post-treatment and again 6-weeks after discontinuation of treatment (Table 1). Treatment was conducted over ten, 90-minute weekly sessions conducted between September 2012 and November 2012. Each treatment session included: 1) assessment of both trained and untrained word probe lists and 2) administration of the treatment protocol. The Cookie Theft picture description task was administered bi-weekly.

Intervention Protocols

The treatment protocol consisted of five hierarchically ordered levels. All five levels were completed in succession to defined thresholds of success (i.e., 51-80%). Levels 1 and

2 were designed to facilitate lexical retrieval at later stages in the hierarchy by first activating and strengthening the target representation at the semantic level. Levels 3 through 5 were designed to facilitate lexical access at the phonological level. The details of each level are presented in Table 2. The participant was provided a minimum of two rest-breaks during the session as well as additional breaks when requested.

Trained word lists were participant generated. The family tracked new words produced by P1 spontaneously even if not used propositionally on a weekly basis. Whether or not the word was used correctly was irrelevant, only that it was a real-word and intelligible to the family. Words from the family-generated lists that were imageable in black and white line drawings were included in the training word lists. Semantically related untreated words were generated each week and were matched on frequency, imageability, and when possible phonemic structure to the treated words. Criterion for target mastery was the accuracy of lexical retrieval at Levels 3, 4 and 5. Target words were evaluated weekly at the end of each session. Target words produced with >80% accuracy were removed from the training list and considered mastered. Target word produced with <50% accuracy were removed from the training list and considered to be outside of the optimal zone for training. Treated words that met the 51 to 80% accuracy in Levels 3 to 5 were retained on the training list for the subsequent session. New words were added weekly to increase the number of trained targets to 20 words/week.

Homework was assigned at the end of each treatment session and completed daily by P1. Homework tasks involved copying and oral reading of the target words meeting the 51 to 80% accuracy criteria for that week's session.

Intervention Materials

Treatment stimuli were presented to P1 using a 13-inch MacBook Pro laptop screen positioned directly in front of the participant. All stimuli were presented using Microsoft PowerPoint. Picture stimuli were presented as black and white line drawings on a white background. Orthographic stimuli were presented in lower case black lettering on white background. The clinician researcher provided the auditory verbal stimuli. All assessment and treatment sessions were audio-recorded using a Panasonic RR-US570 MP3 audio recorder and video-recorded using a Canon VIXIA HF200 HD camcorder.

Results

Pre-treatment assessment data from the Western Aphasia Battery-Revised (WAB-R) (Kertesz, 2006) classified P1's aphasia type as conduction aphasia with the following pattern of deficits: 1) Poor repetition; 2) Borderline Non-fluent spontaneous spoken language, with islands of fluent output; 3) Better semantic access (i.e., Pyramids and Palm Trees, Howard, 1992) relative to lexical access in confrontation naming (i.e., Boston Naming Test (Goodglass, 1992); 4) Poor confrontation naming; and 5) High frequency of complex phonological paraphasias.

Detailed data from the post-treatment and 6-week follow-up standardized language measures are presented in Table 1. Briefly post-treatment gains were observed in: 1) Auditory-verbal comprehension on the WAB-R; 2) Reading of sentences and functional information on the Reading Comprehension Battery for Aphasia-2 (RCBA-2) (LaPointe & Horner, 1998); and 3) Naming and word finding on the WAB-R. These gains were maintained at 6-weeks post treatment. Modest gains in trained word stimuli were observed and maintained 6-weeks post treatment (Table 1).

Correct Information Units (CIUs) (Nicholas & Brookshire, 1993) from the Cookie Theft Picture description are presented in Table 1. Results show a marked improvement in CIUs pre-treatment to post-treatment. However, improvement was not sustained at 6-weeks post-treatment.

Discussion

The results of this single-case study demonstrate that a multi-modal combined approach focusing on both semantic and phonological processes for lexical retrieval was effective in improving receptive and expressive language for an individual with chronic conduction aphasia. The potential effectiveness of this unique multimodal, combined treatment approach is evidenced in gains made in trained versus untrained words. Collectively, these findings along with improvements observed on standardized language measures may further substantiate the effectiveness of the current novel treatment approach for treated stimuli, generalization of treatment effects to untreated areas of language, and maintenance of treatment effects. These results, unique to chronic conduction aphasia, are in keeping with previous research suggesting that combined approaches are successful in obtaining gains in lexical access (Best, Herbert, Hickin, Osborne, & Howard, 2002; Herbert, Best, Hickin, Howard, & Osborne, 2003). By combining a semantic and phonological approach to intervention we were potentially able to capitalize on the participant's in semantic access (Baldo et al., 2008) to facilitate improvement in articulatory loop processes (Nickels et al., 1997).

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Table 1.

Results (total possible score)

		Pre-Treatment	Post-Treatment	6-weeks Post
Western Aphasia Battery – Revised (WAB-R)				
Aphasia Quotient (AQ, 100)		31.7	39.4	38.8
Spontaneous Speech (20)		10	12	11
Auditory Verbal Comprehension (200)		101	132	122
Repetition (100)		1	0	0
Naming and Word Finding (100)		7	11	23
Boston Naming Test (BNT) (30)		20	21	21
The Pyramids and Palm Trees Test (52) (P&P)		46	45	46
Psycholinguistic Assessment of Language Processing in Apahasia (PALPA) subtest#14 (15)		10	11	10
Reading Comprehension Battery for Aphasia - 2 (RCBA-2)	Word-Visual (10)	10	10	10
	Word-Auditory (10)	10	10	10
	Word-Semantic (10)	10	10	10
	Functional Reading	0	4	6
	Synonyms	6	0	6
	Sentence-Picture	5	8	8
Communication Effectiveness Index		5.75	5.77	
Trained Words (% correct)			27.85	26.58
Matched Untrained Words (% correct)			1.27	10.13
%CIUs		9	39	4

Table 2.

Treatment Program Design: Description of Levels

Level	**Description**
Level 1	Written word to picture matching task consisting of the target embedded within a field of five foils that were both semantically related and when possible phonologically related
Level 2	Three 'yes'/'no' semantic verification questions relating to the target. Presented in auditory mode and answered verbally.
Level 3	Read aloud the target word
Level 4	Repetition of the target word (x 3 trials)
Level 5	Confrontation naming of the target

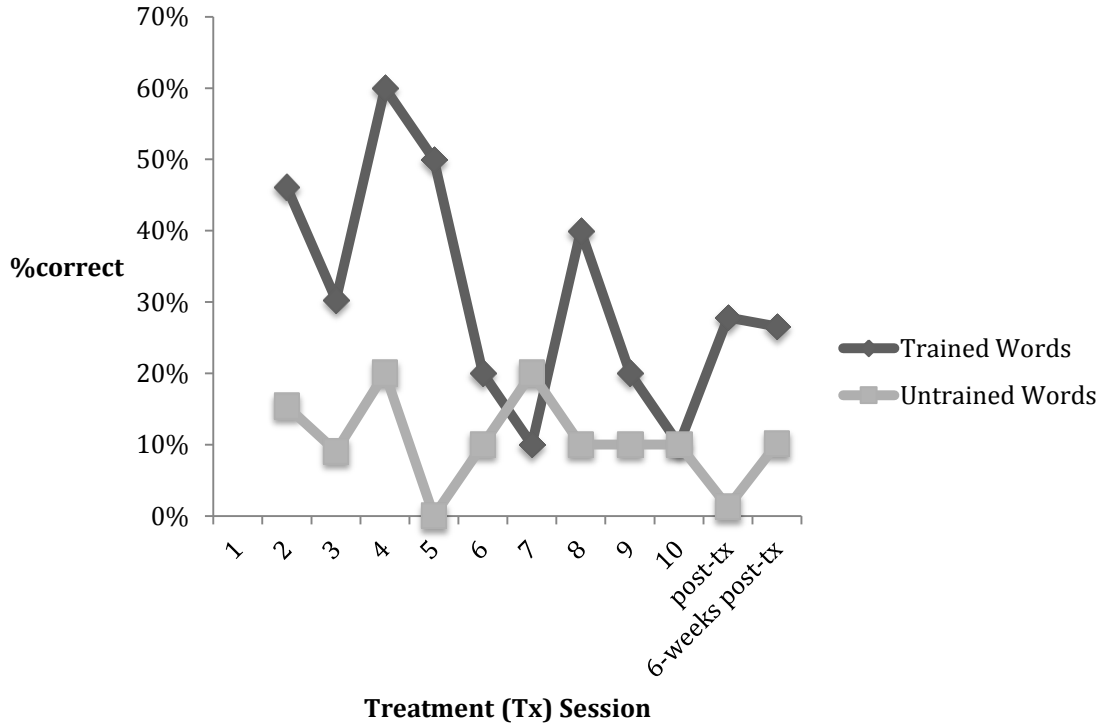

Figure 1. *Percent correct of trained and untrained words across treatment and post-treatment assessment sessions.*