Evidence Based Intervention for Primary Progressive Aphasia

by

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Abstract

Primary Progressive Aphasia (PPA) is a neurodegenerative syndrome that initially affects language while other aspects of cognition remain relatively spared. Although the symptoms of PPA become progressively worse, speech-language pathologists can provide behavioral interventions that help the affected individual communicate. The purpose of this study was to investigate treatment outcomes of two types of approaches – impairment-based and compensatory – in teaching an individual with PPA specific words and conversational skills. The study was conducted in two phases. A single-subject experimental design was used to examine outcomes associated with treatment in both phases.

The first phase of the study involved implementation of a cueing technique (impairment-based approach) to improve the participant's word-finding ability. In the second phase, a communication wallet was designed to facilitate the participant's functional conversational abilities when talking about three topics: family, hobbies, and weekly schedule. Results were mixed. In the first phase, no significant treatment outcomes were observed. In the second phase, the participant demonstrated a modest increase in the number of relevant statements made when discussing the topics using the communication wallet. Clinically, the results highlight the need to begin treatment early in the progression of PPA to achieve optimal outcomes, and to use multiple measures of outcome to assess therapy benefits beyond impairment based outcomes.

Preface

This thesis is an original work by Gillian Dixon. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name “Written Language Processing in Aphasia and Primary Progressive Aphasia”, No. Pro0001267, May 14, 2010 – May 13, 2016. No part of this thesis has been previously published.

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Introduction

Primary Progressive Aphasia (PPA) is commonly recognized as a subtype of dementia wherein language processes and functions are affected prior to the emergence of cognitive deficits (Bonner, Ash & Grossman, 2010; Henry et al., 2013). Although PPA has been studied in terms of its presentation and symptomatology, there are few studies on interventions for PPA. The purpose of the current study was to examine a phased approach to intervention for an individual with PPA. In Phase I, an impairment-based approach to improving lexical retrieval (naming) abilities was used. In Phase II, a compensatory-based approach to improving conversational abilities was implemented.

Primary Progressive Aphasia

PPA is associated with neurodegenerative disease and atrophy in the left cerebral hemisphere, most commonly the dominant hemisphere for language processing (Bonner et al., 2010; Henry et al., 2013).

Gorno-Tempini et al. (2011) state that in order to be diagnosed with PPA, the individual must meet the following inclusion criteria:

1. The primary characteristic is language difficulty;
2. The impairments must affect the individual's daily living activities that require use of language; and,
3. The primary deficit for the first ~2 years of illness must be aphasia.

There are three variants of PPA that have been recognized: logopenic variant (lvPPA), semantic variant (svPPA), and nonfluent/agrammatic variant (nfvPPA). Each variant is characterized by different patterns of neurodegeneration and unique language deficits. A summary consensus of diagnostic criteria of PPA variants is shown in Table 1.

Table 1

Summary of diagnostic criteria of PPA variants

	Speech-language core characteristics	**Speech-language-associated characteristics**	**Typical imaging findings**	**Predicted neuro-pathology**
Nonfluent variant	One of the following must be present: ● Agrammatic production ● Effortful, halting speech with speech sound errors	Two of the following must be present: ● Agrammatic comprehension ● Spared single-word comprehension ● Spared object knowledge	Left anterior perisylvian/fronto-insular atrophy or hypometabolism	FTLD-tau*, FTLD-TDP-43**
Semantic variant	Both of the following must be present: ● Impaired comprehension naming ● Impaired single word comprehension	Three of the following must be present: ● Poor object knowledge ● Surface dyslexia/dysgraphia ● Spared repetition ● Spared grammar and motor speech	Asymmetrical (L>R) anterior temporal lobe atrophy and/or hypometabolism	FTLD-TDP-43
Logopenic variant	Both of the following must be present: ● Impaired word retrieval in spontaneous speech and confrontation naming ● Poor repetition of sentences and phrases	Three of the following must be present: ● Phonologic errors in speech ● Spared single-word comprehension and object knowledge ● Spared motor speech ● Absence of agrammatism	Left posterior perisylvian/ temporoparietal atrophy and/or hypometabolism	Alzheimer's disease

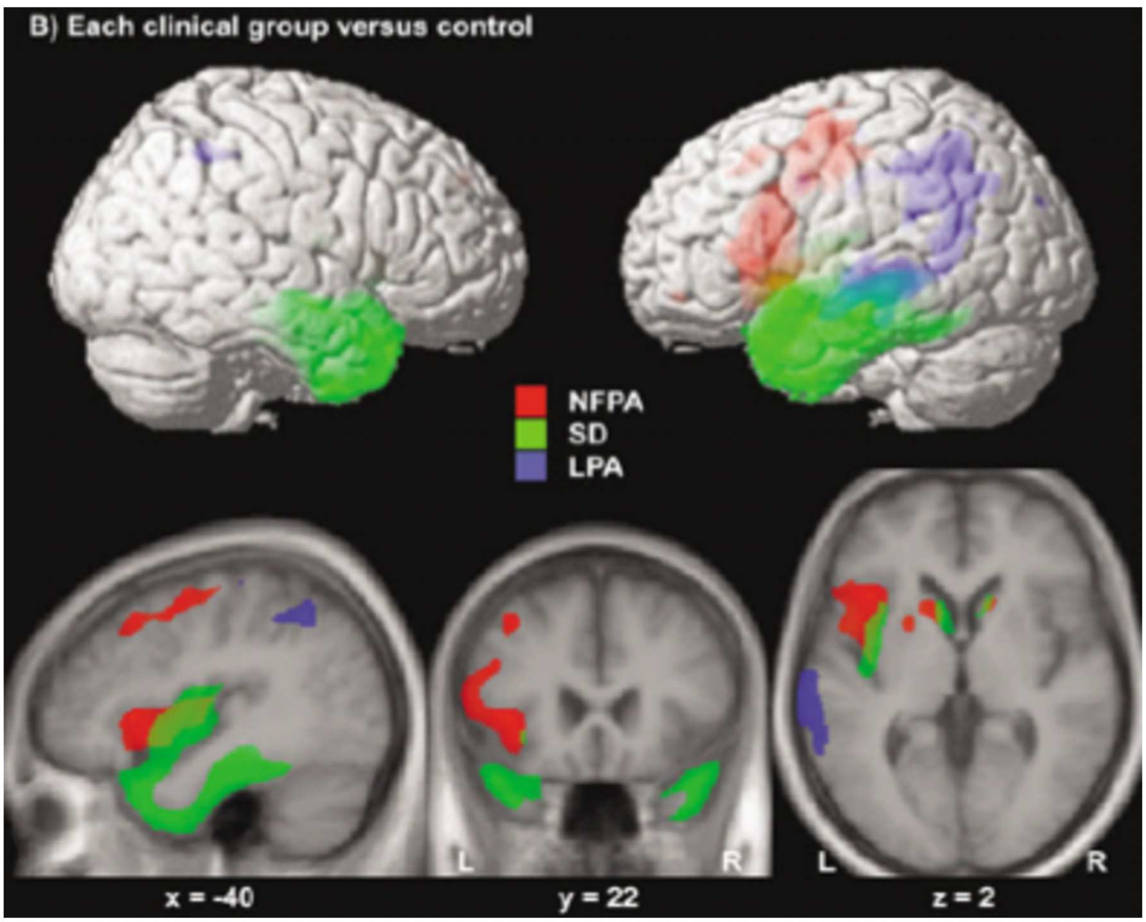
Adapted from Henry, Wilson & Rapcsak (2014)
**FTLD-tau refers to the primary pathology causing the impairments as Fronto-Temporal Lobar Degeneration (FTLD) associated with collections of the tau protein in the brain.*
***FTLD-TDP-43 refers to the primary pathology causing the impairments as FTLD associated with "dystrophic neurites, neuronal cytoplasmic, and intranuclear inclusions" in the brain (Henry, Wilson & Rapcsak, 2014, p. 256).*

LvPPA is also referred to as logopenic progressive aphasia or progressive mixed aphasia (Bonner et al., 2010). It is characterized by word-finding difficulties (anomia), phonemic paraphasias, and slowed spontaneous speech output (Bonner et al., 2010). Individuals with lvPPA also typically present with intact grammar and speech motor control. Cognitively, lvPPA is characterized by poorer episodic memory than svPPA and nfvPPA, and difficulties with auditory-verbal short-term memory tasks (such as sentence repetition and digit/word/letter span tasks) (Bonner et al., 2010). Auditory comprehension is also impaired. The difficulties with repetition and speech comprehension that are experienced by individuals with lvPPA can be explained by damage to the phonological loop function (Bonner et al., 2010). Clinically, labeling of lvPPA is inconsistent due to discrepancies in the usage of the terms fluent and nonfluent in the literature. Some individuals with lvPPA are labeled as having fluent speech due to intact grammar and motor control. Others have speech characterized as nonfluent due to slowed speech output and anomia. It is suggested that the descriptor nonfluent be reserved for those individuals who experience articulation and grammar deficits (Bonner et al., 2010). LvPPA is associated with cortical degeneration of posterior perisylvian and inferior parietal areas (Bonner et al., 2010). Refer to Figure 1 for a visual representation of the different patterns of atrophy for each subtype of PPA.

SvPPA is frequently referred to as semantic dementia. It is characterized by impaired semantic knowledge – naming tasks (words and pictures), category naming, and object knowledge (Bonner et al., 2010). SvPPA is considered a fluent variant; individuals will typically present with normal speech rate, good articulation, and intact grammar (Gorno-Tempini et al., 2004). Affected individuals experience single word comprehension difficulties as well as surface dyslexia and dysgraphia (Bonner et al., 2010; Gorno-Tempini et al., 2011). Individuals with surface dyslexia and dysgraphia will read and write irregularly-spelled words based on how they look on the surface (e.g. “sew” will be read as /su/) (Gorno-Tempini et al., 2011). SvPPA is most often associated with frontotemporal lobar degeneration (FTLD); the atrophy affects the anterior temporal lobe region, as well as the anterior regions of the hippocampus and amygdala (Bonner et al., 2010).

Figure 1

Patterns of Atrophy for PPA Subtypes



From Gorno-Tempini et al. (2004) (Used with permission)

NfvPPA is also often referred to as nonfluent progressive aphasia. It is characterized by slow, effortful speech containing disfluencies such as hesitations and prolongations (Bonner et al., 2010). Sentence structure is often less complex. Unlike in lvPPA and svPPA, individuals with nfvPPA make grammatical errors when speaking, and also have difficulty understanding complex grammatical structures, however, single word comprehension is often spared (Bonner et al., 2010; Gorno-Tempini et al., 2011). Anomia is also present, although not as severe as in svPPA and lvPPA. NfvPPA has been likened to Broca's aphasia, a nonfluent aphasia resulting from left hemisphere stroke (Bonner et al., 2010). Apraxia of speech (AOS), a disorder affecting articulatory planning, often co-occurs with nfvPPA, and is thought to be the primary cause of the disfluencies seen in individuals with nfvPPA (Gorno-Tempini et al., 2004). The articulation and speech sound errors made by individuals with nfvPPA are inconsistent (Gorno-Tempini et al., 2011). NfvPPA is associated with atrophy primarily in the left cortical hemisphere in the anterior perisylvian region. Atrophy spreads across the left dorsolateral cortex and left superior temporal cortex, eventually extending into the parietal lobe (Bonner et al., 2010).

Treatments for PPA

Due to the progressive nature of PPA, Henry, Wilson and Rapcsak (2014) propose a phased approach to treatment, focusing on impairment-based/restitutive approaches in the early stages of the disorder and progressing to compensatory or augmentative approaches to treatment in the later stages. Because the research on interventions for people with PPA is in its infancy, little is known about the outcomes of such treatments, particularly in the later stages. However, word finding deficits are common to all types of PPA; thus, treatments focused on impairment-based approaches for lexical retrieval have received the most attention in the research literature.

Restitutive Approaches

Semantic variant PPA. Jokel, Rochon, and Leonard (2006) designed a home-based program that was used for a participant presenting with svPPA. The participant's speech was fluent but progressively anomic at each session. Pictures to train naming and comprehension were selected from the *Peabody Picture Collection* (Dunn & Dunn, 1983). Testing involved presenting the pictures and asking the participant to name each picture. Naming improved significantly for treated items that the participant could not name at baseline ($p = .001$). At 1- and 6-month follow-up assessments, naming of treated items was significantly greater than untreated items ($p < .0001$). Heredia, Sage, Lambon Ralph, and Berthier (2009) also found similar results when training object names with a person with svPPA. The participant was able to relearn and retain a total of 28 names for common objects. The results from both studies indicate that improvement in lexical retrieval is possible even when language skills are progressively deteriorating.

Logopenic variant PPA. Newhart et al. (2009) designed a lexical retrieval cueing hierarchy for one participant with lvPPA. The participant presented with anomia, circumlocutions, and occasional phonemic paraphasias. Her word comprehension was intact. The treatment consisted of a cueing hierarchy aimed at naming items of fruits/vegetables and clothing. The participant was given a notebook containing the written label for each item. Cues were presented in order until the participant named the object correctly, and then presented in reverse order to elicit uncued naming. The participant's post-treatment accuracy was significantly higher than pre-treatment accuracy ($p=.001$) in all categories (trained and untrained). She also showed generalization to untrained items in different categories.

Beeson et al. (2011) also designed a lexical retrieval intervention for a participant who presented with a profile consistent with lvPPA: significant anomia but spared semantic knowledge, syntactic skills, motor control, and nonverbal cognition. Lexical retrieval was treated using a generative naming task, which is considered to be more challenging than confrontation naming because it involves retrieving words from semantic categories under a time constraint. The training involved presenting the participant with photographs of each item including labels and asking the participant to name the item. The labels were subsequently removed and the participant was instructed to attempt naming the item again. The participant was also asked to name items within the same semantic category that were not pictured, as well as those that were pictured.

Direct treatment effects of this study included the participant's ability to name items within the trained categories, as well as items on untrained categories. The participant also used self-cueing strategies. A *d* statistic was calculated to quantitatively measure treatment effect size. Immediately after treatment, the *d* statistic was 2.31 on trained categories and 1.44 on untrained categories. Three weeks post-treatment, the *d* statistic was 2.17 on trained categories and 3.54 on untrained categories. These results suggest that this semantically based treatment was effective for improving the participant's naming ability. Qualitatively, it was reported that his conversation reflected more efficient word retrieval post treatment.

Henry et al. (2013) implemented a lexical retrieval hierarchy with two individuals with PPA. The first individual (SV) was diagnosed with the semantic variant (svPPA) and experienced marked anomia and mild written language impairment. SV's memory and nonverbal cognition was relatively preserved. The second individual (LV) was diagnosed with the logopenic variant (lvPPA) and experienced frequent pauses, naming errors, and phonological paraphasias. LV's semantic knowledge was spared. The treatment approach was designed to strengthen the individuals' remaining semantic, orthographic, and phonological knowledge. A lexical retrieval cueing hierarchy was used to train twenty items for each participant. While the treatment protocols were the same for both participants, the homework protocols differed. SV was instructed to repeat the first three steps of the cueing hierarchy, and LV was instructed to perform a modified *Copy and Recall Treatment* protocol, a treatment designed to strengthen writing skills to assist in naming ability (*CART*; Beeson & Egnor, 2006). Although LV experienced cognitive decline throughout treatment, a weighted *d* statistic of 7.55 for all trained items and 2.04 for the untrained set was reported. This result suggests that the lexical retrieval training was effective in increasing the participants' ability to name the target items. Additionally, the gains were maintained at post-treatment measures and the participants also generalized the self-cueing strategies to untrained items. The participants reported increased confidence in their conversational skills.

Compensatory Approaches

An in-depth literature search has revealed a current lack of evidence on compensatory approaches for the treatment of communication disorders associated with PPA. One study by Pattee, Von Berg, and Ghezzi (2006) focused on the effect of an alternative and augmentative communication (AAC) approach for an individual with PPA and apraxia of speech. The participant's spoken output was less than 20% intelligible at the time the study was performed. Her speech was characterized by articulatory errors, sound and syllable deletions, part word productions, and very few function words (Pattee et al., 2006). American Sign Language (ASL;

for which the participant had previously received basic training) and a text-to-speech device were used as output methods to describe pictured activities. The subject was asked to describe the activities using whichever method she preferred; the researchers focused on eliciting an agent, action, object, and "WH" concepts. The outcome variable of interest was communicative effectiveness, defined as number of words, information units, and percentage of correct information units. The participant produced increased numbers of correct information units using both ASL (increase of 24%) and the text-to-speech device (increase of 2%) (Pattee et al., 2006). The researchers also determined that the participant more often used ASL to describe the pictures as "she did not feel 'normal' when using the [text-to-speech] device" (Pattee et al., 2006, p 152).

The dearth of evidence for the use of compensatory strategies, such as electronic and non-electronic AAC, with individuals who have PPA prompted a search of research evidence related to the use of such strategies with individuals who have a progressive dementia of the Alzheimer's type. Although communication wallets and books have been used with individuals who have severe, chronic aphasia post-stroke, the presence of dementia among individuals in the middle stages of PPA makes it necessary to evaluate the research evidence for communication book use with individuals who have cognitive as well as language and communication impairments.

There is a growing body of research on the effects of non-electronic memory aids on communication of individuals with dementia. Bourgeois (1992, 1993) pioneered this work with individuals who had Alzheimer's dementia. Memory aids generally take the form of books (larger, binder-size form) or wallets (smaller, more portable form) that include a collection of sentence and picture stimuli designed to prompt recall of the stated facts and other related factual information (Bourgeois, 2014). Because many individuals with even middle to later stage Alzheimer's dementia retain the ability to read and recognize familiar people, places and things, memory books are designed to capitalize on these abilities and facilitate remembering during communication interactions that involve the memory book.

In a recent systematic review of the literature on communication interventions for individuals with dementia, Egan, Bérubé, Rancine, Leonard and Rochon (2010) reported that, compared to other interventions, memory aids demonstrated the clearest effectiveness in improving patients' discourse related to specific topics that were linked to the memory aids and appeared to be effective in enhancing topic maintenance, as evidenced by improvement in time on topic, words per topic, and fewer topic changes. The authors and others (Bourgeois, 2014) note that training care partners in the use of memory aids is an essential component of the success of the intervention. In summary, the current research evidence provides a promising basis for the use of impairment-based therapy for individuals with PPA of different subtypes. However, in the majority of the studies, the participants had language deficits in the absence of frank cognitive deficits. Little is known about the effects of impairment-based or restitutive naming treatments on language abilities of individuals with more advanced PPA when dementia is also present. Further, few if any studies exist in which researchers use compensatory approaches to address the cognitive-communication limitations of people with PPA. Although the evidence is compelling for the use of memory aids with individuals who have Alzheimer's dementia, little is known about the effects of memory aid use on the conversational abilities of individuals with language and cognitive impairments that occur in PPA. There is a clear need to examine these types of interventions in systematic research studies.

Purpose of the current study

The purpose of this study was to address the gap that exists in the treatment literature for PPA by investigating the effects of a two-phase treatment model for an individual with lvPPA that involved a restitutive and compensatory approach to communication deficits, implemented over a period of 18 months. Specifically, the study focused on the following two research questions:

1. What is the effect of lexical retrieval training on the language abilities of an individual with lvPPA? (Phase I)
2. What is the effect of a memory aid on conversational abilities of an individual with lvPPA? (Phase II)

Methods: Phase I

Participant

At the time of the initial evaluation in September 2013, DL was a 71-year-old right-handed woman who reported a 5-year history of gradually increasing difficulty with language. DL completed high school and a Bachelor's degree, and worked as a social worker prior to onset of her language difficulties. She retired in 1999. In 2011, DL was referred to the Glenrose Rehabilitation Hospital due to her difficulties with language. At the time of this initial assessment, DL's primary difficulties included word retrieval difficulties, paraphasic errors, as well as mild difficulty with episodic memory (remembering details of events). DL was evaluated by a clinical neuropsychologist and was diagnosed with primary progressive aphasia (PPA). At the time, DL noted she had difficulty using the telephone and socializing. She reported difficulty keeping up with conversation and was experiencing decreased confidence.

Her husband contacted the university in August 2013 to inquire about treatment options for DL. At the time of the initial evaluation at the University of Alberta in September 2013, DL's primary complaint was frustration in conversation as a result of word finding deficits. Of note within DL's family history is a diagnosis of dementia in DL's mother.

Initial Behavioural Evaluation. A comprehensive language and cognitive evaluation was completed at the University of Alberta prior to treatment. DL's performance on the *Western Aphasia Battery - Revised* (*WAB-R*; Kertesz, 2009), was consistent with conduction aphasia (Aphasia Quotient = 53.7 out of 100). See Table 2 for the *WAB-R* subtest scores. Her spontaneous speech was nonfluent and marked with word retrieval difficulties, phonemic paraphasias, and neologisms.

Table 2

Pre-treatment WAB-R subtest scores

Subtest	Score	Percent (%)
Spontaneous Speech	10 / 20	50
Auditory Verbal Comprehension	7.45 / 10	74.5
Repetition	6.3 / 10	63
Naming and Word Finding	3.1 / 10	31
Total	**26.85 / 50**	
Aphasia Quotient	**53.7**	

Severe anomia was evident on the *Boston Naming Test* (*BNT*; Goodglass & Kaplan, 2001), on which she correctly produced only 8 of 60 items. These difficulties were also seen on the *Object Naming* subtest of the *WAB-R* (3/20 objects named without cues). During instances of word retrieval difficulty, DL often uttered interjections such as "um." The picture version of the *Pyramids and Palm Trees Test* (*PPT*; Howard & Patterson, 1992) was administered to determine the status of DL's semantic and conceptual knowledge of words. Her score of 82.6% (43/52 items correct) on the *PPT* indicates some impairment with semantic knowledge; a participant who scores 90% or better is considered to have no clinical impairments (Howard & Patterson, 1992).

The oral reading modality of the *Arizona Battery for Reading and Spelling* (*ABRS*; Beeson & Rising, 2010) was administered to assess DL's single-word reading abilities. The *ABRS* comprises 80 words, matched for length, frequency and spelling regularity. DL's overall accuracy was 73.7% correct. The results can be seen in Table 3 below. No effects of spelling regularity (31/40 for regularly spelled words, 28/40 for irregularly spelled words) nor frequency (28/40 for high frequency words, 31/40 for low frequency words) were observed. However, the majority of her errors were phonologically plausible errors (e.g., DL read "pint" as [pɪnt]). Other errors included deletions of consonants (e.g., "chant" read as "chan").

Table 3

Pre-treatment scores on the ABRS

Word Type	**Raw Score**	**Percent Correct (%)**
Regular spelling	31 / 40	77.5
Irregular spelling	28 / 40	70
High frequency	28 / 40	70
Low frequency	31 / 40	77.5
Total Percent Correct (%)		**73.7**

The *Reading Comprehension Battery for Aphasia - 2* (*RBCA-2*; LaPointe & Horner, 1998) was used to determine DL's abilities in additional literacy skills. The administered subtests and scores can be seen in Table 4. DL's scores on the *RBCA-2* indicate some difficulty with functional reading, identifying synonyms, and reading syntactically complex sentences.

Table 4

Administered RCBA subtests and scores

Subtest	**Raw Score**	**Percent Correct (%)**
I. Word-Visual (VV)	10	100
II. Word-Auditory (WA)	10	100
III. Word-Semantic (WS)	9	90
IV. Functional Reading (FR)	4	40
V. Synonyms (SY)	6	60
VI. Sentence-Picture (SP)	8	80
X. Morpho-Syntax (MS)	5	50
XIV. Lexical Decision (LD)	20	100
XVI. Oral Reading: Words (ORW)	30	100
XVII. Oral Reading: Sentences (ORS)	30	100

DL's nonverbal cognitive skills were assessed using the *Raven's Coloured Progressive Matrices* (*RCPM*; Raven, Raven, & Court, 2003). DL's score of 19/37 can be compared to the mean normative value of 23.9 ±6.65 for individuals between 71-80 years of age, as reported by Basso, Capitani & Laiacona (1987). This suggests that DL's nonverbal cognitive and visuospatial skills were within normal limits for her age on the *RCPM.* Selected subtests from the *Arizona Battery for Communication Disorders of Dementia* (*ABCD*; Bayles & Tomoeda, 1993) were used in order to further quantify DL's cognitive-linguistic impairments. The administered subtests and scores can be seen in Table 5. Standard scores were computed using the normalized values for individuals with mild Alzheimer's disease (AD). Her scores on the *Story Retell – Immediate* subtest indicate some minor difficulty with episodic memory; however, the score on the *Story Retell – Delayed* subtest was within normal limits. DL's recognition of words was almost perfect, suggesting more difficulty in direct recall of learned material.

Table 5

Administered ABCD subtests and scores

Subtest	Raw Score	% Correct	Mean Raw Score - Mild AD (SD)	Mean Raw Score - Older Controls (SD)
Story Retell – Immediate	8/17	47%	7.1 (3.8)	13.4 (3.2)
Story Retell – Delayed	7/17	41%	0.9 (3.1)	11.1 (5.4)
Word Learning – Free Recall	7/16	44%	2.1 (2.1)	7.3 (2.5)
Word Learning – Cued Recall	3/16	19%		
Word Learning - Total Recall	10	31%	7.4 (3.9)	15.2 (1.2)
Word Learning – Recognition	47/48	98%	35.3 (7.7)	46.3 (2.8)

Summary of Pre-Treatment Assessment Findings. At the time of assessment, DL primarily experienced some challenges with word finding, reading irregularly spelled words and complex sentences. While classified as having a fluent aphasia, DL's overall verbal expression in conversation was characterized by frequent pauses, paraphasias, neologisms, and word-finding difficulty. Context was frequently lost in conversation, but DL could be understood with the use of supportive communication strategies, such as writing keywords and rephrasing sentences. Although her scores on non-verbal problem solving tasks were within normal limits for her age, DL showed difficulty with the tasks, demonstrated by long response times (10+ seconds) and facial expressions showing confusion. Areas of strength for DL included conceptual knowledge and semantics, recognition of learned material, and reading less complex words and sentences. These results suggested that DL could potentially benefit from lexical retrieval training, an approach designed to "engage and strengthen residual semantic, orthographic, and phonological knowledge" (Henry et al., 2013, p. 148).

Treatment: Phase I

Lexical retrieval training. The treatment approach implemented for DL was adapted from the lexical retrieval strategies designed by Henry et al. (2013). This approach includes a sequence of tasks (i.e., a cueing hierarchy) with the aim of training self-cueing techniques in retrieving semantic, orthographic and phonologic information. The exact procedure was tailored to DL, who was 72 years old at the beginning of Phase I treatment in May 2014.

Design and Procedures. A single-subject multiple baseline across behaviors design was used to assess the effects of the treatment on DL's lexical retrieval abilities. The nature of this design requires that different behaviours, or dimensions of a behaviour, are targeted at staggered intervals (Thompson, 2006). In the current study, the behavior being targeted was spoken word naming of pictured stimuli. The treatment occurred across two sets of five pictures.

Stimuli. The pictures representing specific lexical items were selected from the *Philadelphia Naming Test* (*PNT;* Moss Rehabilitation Research Institute, 1998), a 175-item picture-naming test. DL completed the computerized naming test over two sessions. Of the 175 items, DL correctly named 42, incorrectly named 127, and had no response for 6. Forty-eight lexical items that were not named correctly on the PNT were selected for inclusion in the study. Of these 48 items, 30 were separated into six sets of five and balanced for frequency, word length, imageability, number of syllables, and spelling using data from the *Neighborhood Watch* program (*N-Watch*; Davis, 2005). The above factors can influence naming accuracy (Davis, 2005). The 30 balanced items were the items to be trained; the remaining 18 were used for control purposes and were not trained.

Baseline. Baseline probes of the 48 items were administered three times prior to beginning treatment in a confrontation naming format. For all baseline probes, coloured photographs of each item were prepared and pictures presented in random order. In confrontation naming, no cues are given aside from the initial question, "What is this?" Items were scored as correct if they were named correctly within 10 seconds. No corrective feedback was provided.

Treatment. The words were divided into sets of five for training in a multiple baseline format. A cueing hierarchy ranging from least to most supportive cueing was used (see Table 6 for the cueing hierarchy used in treatment). The pictures in each set were presented individually. Treatment sessions were approximately 30 minutes in length and were held once a week at the University of Alberta. One session was cancelled due to examiner illness. In total there were 12 treatment sessions over 13 weeks from May 2014 to September 2014. Treatment was time-based versus criterion-based. That is, after six sessions, regardless of naming accuracy on the first set of words, training on the second set of words was initiated.

Face-to-face treatment sessions were supplemented with weekly homework. Homework sheets consisted of printed pictures accompanied with written representations of the current treatment set of five words (see example in Appendix C), and DL was given written instructions to perform a modified *Copy and Recall Treatment (CART*; Beeson & Egnor, 2006) procedure, involving copying the written word with the example in view, then covering the written examples while writing the word from memory (Beeson & Egnor, 2006). DL was assisted with the homework by family members or her professional caregiver. Twice DL did not fully complete the homework and was given an extra set of homework to complete at the treatment session the following week.

Table 6

Cueing hierarchy used for lexical retrieval training

Lexical Retrieval Cueing Hierarchy	
Present picture for naming	
1. No cue	Ask: "What is this?" or "Tell me the name of this" Wait 10 seconds If incorrect, move to #2. If correct, move to #4 and work upwards.
2. Phonemic cue	Provide the first sound for participant: "It starts with ___" Wait 10 seconds
3. Orthographic cue / self-cue	(a) Ask: "Can you write the name of it?" Wait 10 seconds; as much time as needed to write the word If incorrect, move to (b). If correct, move to (d). (b) Ask: "Can you write the first letter?" Provide phonemic cue again Wait 10 seconds; as much time as needed to write the word If incorrect, move to (c). If correct and writes whole word, move to (d). (c) Print the word in all capitals (d) Ask: "What does this say?" Ask participant to read the word aloud Have participant copy the word twice and read it aloud once more
4. Repetition	Say the word and have the participant repeat it five times
5. "What is this?"	Ask participant what the picture is while pointing to the word and the picture. Use repetition if necessary to end with success.

Dependent variables. The primary dependent variable of interest consisted of performance probe data on percentage correct spoken naming on the thirty items assessed during probes conducted at the beginning of each treatment session. As in the baseline probes, items were scored as correct if they were named correctly within 10 seconds. No cues were provided during the pre-treatment/performance probes, aside from the initial question, "What is this?"

In addition to the probe data on naming, within session treatment session data on written naming accuracy and level of cues required were also recorded. Descriptive data on DL's response to treatment were also collected.

Results: Phase I

Lexical Retrieval Training

Single-subject multiple baseline data were collected during the treatment block. DL's response to treatment is shown in the figures below. Data was taken during probe sessions to gain information about DL's generative naming skills and written accuracy, and treatment sessions provided data on naming accuracy with cues. A quantitative measure of treatment effect size, the *d* statistic, was based on DL's spoken naming skills throughout treatment and will be described below. Descriptive and observational data regarding DL's performance during sessions is also included.

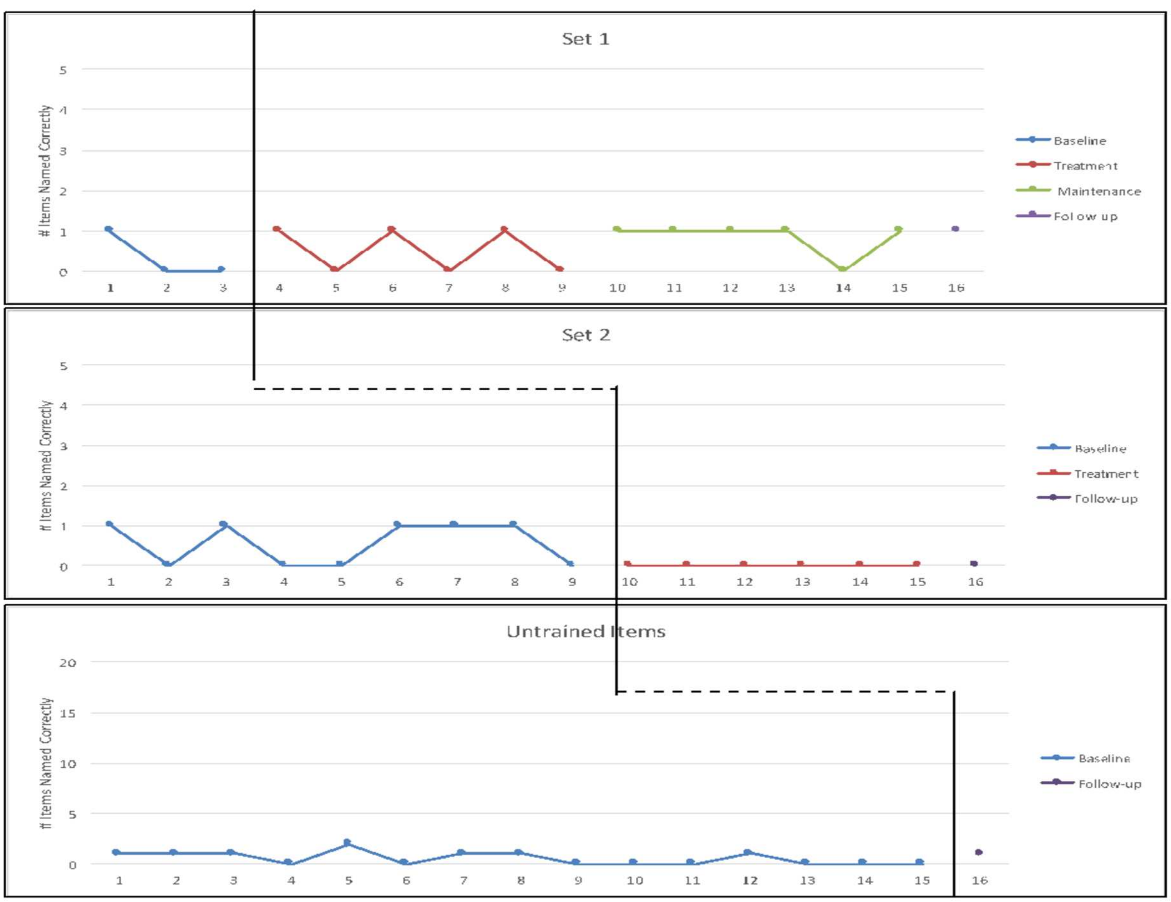
Performance probe data on spoken naming. The original treatment plan included training six sets of five words (30 lexical items). Ultimately, however, only two sets of five words were trained because of time constraints related to student clinician and participant availability, and because of a lack of participant learning of the first two sets.

To examine the effects of the lexical retrieval training on naming performance, the data from baseline probes, performance probes, maintenance probes and the follow-up probe were compiled into visual graphs, with data points representing number of items named correctly each session. The follow-up probe was conducted 8 weeks post-treatment.

Data will be presented on the 30 items that comprised the final set of items in the performance probes. Figure 2 shows the data for items trained in Set 1, items trained in Set 2, and the remaining 20 lexical items that were untrained. Each item in Set 1 and Set 2 was probed in every session until the end of the treatment block. Sessions are indicated on the X-axis, and number of correctly named items is on the Y-axis. Please see Appendix A for a complete list of words with respective accuracy data that were used in the probes.

Figure 2

Items correctly named during probes



Baseline data for each set of trained words are shown in blue in Figure 2. As visualized, baseline probes continued for three sessions for Set 1, and nine sessions for Set 2. Red data points represent the number of items in each set that were correctly named during performance probes that were administered at the beginning of each treatment session. Green data points represent the maintenance period probes of Set 1 words, when training had begun on Set 2.

Visual inspection of the data in terms of slope and trend of the data points reveals limited treatment effects. Nevertheless, effect sizes were calculated to obtain a quantitative measure of potential treatment outcomes.

Effect size for naming accuracy on performance probes. A *d* statistic was calculated to obtain a measure of treatment effect size using data representative of DL's level of performance in the probes. The following equation was described in Beeson and Robey (2006) and was used in this study:

$$d = \frac{\bar{X}_{A2} - \bar{X}_{A1}}{S_{A1}}$$

where $\bar{X}_{A1}$ and $\bar{X}_{A2}$ represent the mean performance levels (i.e., number of items named correctly in each set) of the pre- and post- treatment periods respectively, and S_{A1} represents the standard deviation of the data within the pre-treatment period. Using this procedure, effect sizes for training of both Set 1 and Set 2 were calculated.

Set 1. The *d* statistic for Set 1 was calculated using the data from the 3 baseline probes as a pre-treatment measure; the data from the maintenance period and follow-up probe was used as a post-treatment measure (seen in Figure 2). The *d* statistic for Set 1 was 1.15. A review of 12 studies in lexical retrieval therapy showed that the effect sizes for small-, medium-, and large-sized effects correspond to *d* statistic values of 4.0, 7.0, and 10.1 respectively (Beeson & Robey, 2006). DL's result of 1.15 indicates she experienced little treatment effect after training the stimuli in Set 1.

Set 2. The *d* statistic for Set 2 was calculated using the data from the 3 baseline probes as well as the performance probes administered during Set 1 as a pre-treatment measure, and the data from the follow-up probe was used as a post-treatment measure. The *d* statistic for Set 2 was -1.05. This result was likely due to a lack of variance in post-treatment (i.e., having only one follow-up probe). DL did not name any Set 2 items correctly in the follow-up probe. These results indicate that there was no reliable treatment effect after training Set 2.

Within-session data on written naming accuracy. Table 7 shows DL's accuracy in writing the whole words independently when given the opportunity during treatment. Table 8 shows the number of times DL was accurate when writing the whole words correctly following a written cue (i.e., either a part or whole word written by the clinician; DL was then asked to copy it twice).

Table 7

Accuracy writing whole words independently

Word	# Times Correct	# Opportunities Given	% Correct
Set 1			
Chair	6	16	38
Lamp	3	17	18
Spoon	3	15	20
Door	15	15	100
Keys	6	16	38
Set 2			
Church	0	15	0
Plant	0	16	0
Foot	0	16	0

Fork	0	18	0
Glass	0	18	0

Table 8

Accuracy writing whole words with orthographic cues

Word	# Times Correct	# Opportunities Given	% Correct
Set 1			
Chair	6	7	86
Lamp	9	9	100
Spoon	8	8	100
Door*	0	0	-
Keys	6	6	100
Set 2			
Church	10	11	91
Plant	11	12	92
Foot	13	13	100
Fork	9	17	53
Glass	12	15	80

* No opportunities were given for DL to write “Door” with orthographic cues because she wrote it correctly 100% of the time with no cues.

DL showed increased difficulty learning the orthographical representations of the words in Set 2. While she was able to write several words in Set 1 independently, she was generally unable to write words in Set 2 independently without some form of orthographic cueing.

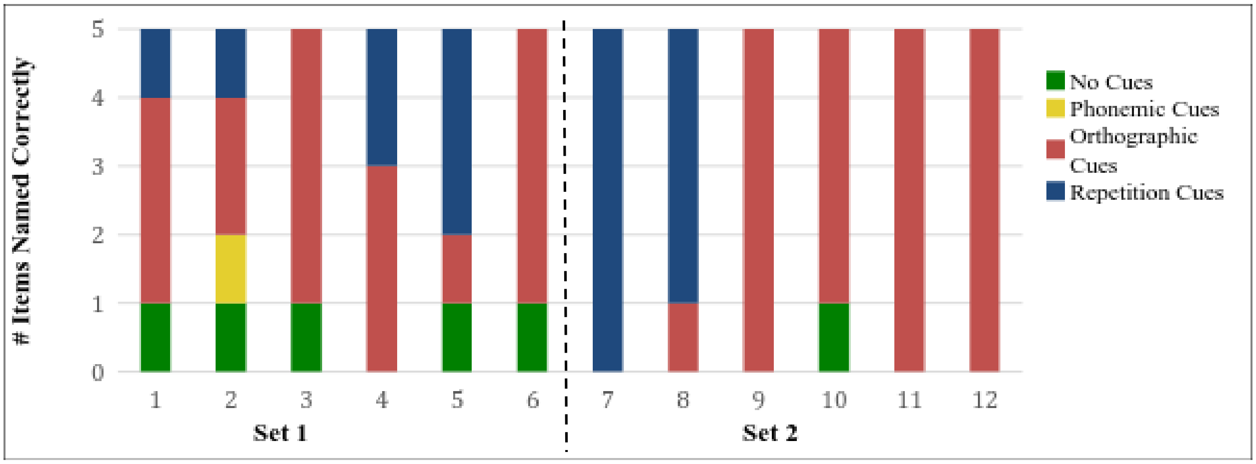
Treatment data on naming accuracy with cueing. Figure 3 shows the lowest level of cueing that was required for DL to achieve an accurate response during treatment sessions for Set 1 and Set 2, respectively. The X-axes indicate the session numbers; training of Set 1 occurred during sessions 1-6, and training of Set 2 occurred during sessions 7-12. The Y-axes indicate the level of cueing required for accuracy. The levels of cueing, from least to most supportive, are as follows:

1. No cue required, aside from the prompt, “What is this?”
2. Phonemic cue (e.g., clinician offered the first sound of the target word).
3. Orthographic cue (e.g., clinician or DL wrote part of or the whole word).
4. Repetition in unison.

Visual inspection of Figure 3 on page 25 indicates that DL was often successful when given orthographic cues during training of Set 1, as noted by the proportion of red columns. DL was still able to achieve correct responses occasionally with no cues (green columns). Once training began on Set 2, the blue columns indicate that DL relied heavily on repetition cues for the first two training sessions. After that, she experienced a high level of success with orthographic cues (red columns), but experienced less success with lower levels of cueing (i.e., no cues or phonemic cues). As seen in Figure 2 on page 20, there was a lack of treatment effect when examining the probe data. However, based upon examination of the within session data in Figure 3, DL demonstrated learning of the stimuli as she required less supportive cues for naming accuracy later in the treatment block.

Figure 3

Level of Cueing Required for Accuracy



Summary of Quantitative Data Analysis. DL had a limited response to treatment for lexical retrieval. No clinically significant improvements were noted in DL's spoken naming ability using the cues provided during treatment. However, orthographic cues were often effective in eliciting correct spoken and written responses from DL during treatment sessions. Orthographic cues comprised either the clinician or DL writing the first few graphemes or the whole word on paper. DL was often successful in both writing and reading the word aloud at this point. DL demonstrated learning of one item in particular during treatment. The stimulus item "keys" was often an effortless word for DL to name in both training sessions and probes.

Clinical Observations

DL showed semantic knowledge and recognition of several items during probes, despite being unable to name the items. For example, DL enjoyed the stimulus "pig" and showed positive affect (demonstrated by smiling and laughing) when presented with the picture. Additionally, when shown "soap" during probes, she engaged in conversation about bathing her grandson. When shown "ring," DL regularly pointed to her own wedding ring or a ring worn by the clinician. When DL was shown "gloves," she would often touch each of her fingers in sequence. DL also enjoyed the item "drum" and would drum her hands on the table to demonstrate her knowledge of the item. To gain further information regarding DL's semantic abilities within-session, an informal probe was given two times after completing the formal performance probe. The clinician wrote on paper three options for one of the items DL had difficulty with and asked her to pick which one the picture showed. For example, when DL was not able to name "pig," the clinician wrote "horse," "dog," and "pig" on a piece of paper and ask DL to point to the word that named the pictured animal. DL immediately identified "pig" as being the correct name.

Post-Treatment Behavioural Assessment

Post-treatment re-assessment of cognitive-communication function was conducted after completion of Phase I**,** using a selection of the standardized tests from the pre-treatment assessment. For a full listing of pre- and post-treatment scores, see Appendix B. Some deterioration of language and cognitive abilities over the course of the past year were noted. The *WAB-R* (Kertesz, 2009) was re-administered post-treatment to determine DL's language skills following treatment. DL's performance on the *WAB-R* was consistent with Wernicke's aphasia. There is a clinically important difference between DL's post-treatment score (Aphasia Quotient = 22.5 out of 100) and her pre-treatment score (Aphasia Quotient = 53.7 out of 100). At the post-treatment assessment, DL's verbal output was marked with neologisms, phonemic paraphasias, and unintelligible circumlocutions. During administration of the *WAB-R*, DL frequently used gestures and sound effects to name and describe objects. See the subtest scores for the post-treatment *WAB-R* in Table 9 below.

Table 9

Post-treatment scores on the WAB-R

Subtest	**Score**	**Percent (%)**
Spontaneous Speech	6 / 20	30
Auditory Verbal Comprehension	3.05 / 10	30.5
Repetition	1.5 / 10	15
Naming and Word Finding	0.7 / 10	7
Total	**11.25 / 50**	
Aphasia Quotient	**22.5**	

The *BNT* (Goodglass & Kaplan, 2001) was also re-administered to determine DL's object naming skills. Anomia was profound; DL correctly produced 2 of 60 items. To assess DL's single-word reading abilities, the oral reading modality of the *ABRS* (Beeson & Rising, 2010) was administered again post-treatment. DL's overall accuracy across the word lists was 73.1% correct. No effects of spelling regularity (31/40 for regularly spelled words, 27/40 for irregularly spelled words) nor frequency (31/40 for high frequency words, 28/40 for low frequency words) were observed. See these scores in Table 10 below. DL's post-treatment scores on the *ABRS* were nearly equivalent to her pre-treatment scores, suggesting single-word reading was not an area affected by any possible cognitive-communication decline.

Table 10

Post-treatment scores on the ABRS

Word Type	**Raw Score**	**Percent Correct (%)**
Regular spelling	31 / 40	77.5

Irregular spelling	27 / 40	67.5
High frequency	31 / 40	77.5
Low frequency	28 / 40	70
Total Percent Correct (%)		**73.1**

DL's nonverbal cognitive skills were re-assessed using the *RCPM* (Raven, Raven, & Court, 2003). DL's score of 17/37 can be compared to the mean normative value of 23.9±6.65 for individuals between 71-80 years of age, as reported by Basso, Capitani & Laiacona (1987). DL's nonverbal cognitive and visuospatial skills fall slightly below the normal limit for her age. This is a decline from DL's pre-treatment score of 19/37.

Selected subtests from the *ABCD* (Bayles & Tomoeda, 1993) were re-administered to gain further insight into DL's cognitive-communication impairments post-treatment. The scores can be seen below in Table 11.

Table 11

Administered ABCD subtests and scores

Subtest	Raw Score	% Correct	Mean Raw Score (Mild AD)	Mean Raw Score (Older Controls)
Word Learning – Cued Recall	4 / 16	25		
Word Learning – Recognition	26 / 48	54	35.3, SD=7.7	46.3, SD=2.8

After administering a task on the *ABCD* designed to help the individual learn the stimuli items, the Recognition subtest was used to determine DL's ability to recognize the words she previously learned. DL's post-treatment score on the Recognition subtest (26/48) declined from her pre-treatment score (47/48). Her score falls below one standard deviation of the normal limit of individuals with mild AD. This score indicates that since beginning treatment, DL had increased difficulty with encoding verbal material and direct recall of learned material.

Summary of Post-Treatment Behavioural Assessment. At the time of the post-treatment assessment, DL experienced significant difficulties with word finding, visuospatial tasks, and encoding and recognizing verbal material. In conversation, DL's overall verbal expression was fluent but difficult to understand due to pervasive neologisms and lack of context. DL's ability to relay her message in conversation decreased from pre-treatment conversations even with the use of supportive communication strategies (such as writing keywords). At post-treatment, DL's ability to understand language was stronger than her ability to express herself. DL also demonstrated continuing skills in reading single words aloud. DL's cognitive decline over the course of Phase I was reflected in her post-treatment communication assessment scores.

Discussion: Phase I

DL did not demonstrate significantly improved skills in naming accuracy for the targeted stimulus items during the treatment program. However, DL demonstrated relative strength in orthographic skills during the course of treatment. Within treatment data showed that she wrote many words correctly, as can be seen in Table 7 on page 22. DL was more successful in writing words independently during training of Set 1, than during training of Set 2. She was also able to copy a word accurately the majority of the time (range = 53-100%) after having difficulty writing it independently (see Table 8 on page). When training Set 2, DL often had trouble differentiating between "fork" and "foot" and appeared to exhibit perseveration in her written response. For example, when asked to write "fork," she would often write "foo-" or "fook." This issue could potentially have been avoided by choosing words that were less orthographically and phonemically similar. Additionally, there seemed to be some interference from Set 1 when DL was asked to write words for Set 2. For example, DL sometimes began writing “ch” (as in the Set 1 word “chair”) before starting over and writing “plant.” At one point, DL wrote the Set 1 word “keys” after being asked to write the Set 2 word, “fork.” In future studies, this type of interference could be avoided by allowing more time between training sets, if feasible.

Based on standardized assessment and clinical observations, it was apparent that DL’s PPA had advanced over the course of this first phase. In terms of relative strengths, she had skills in semantic learning and recognition; she was able to identify words and pictures when presented with choices, often used nonverbal communication (i.e., sounds and gestures) to display her knowledge, and demonstrated increasing familiarity with the stimulus items over the course of treatment. However, her language deteriorated, marked by an increase in neologisms and nonfluent speech, and she also began to display increased difficulty with certain cognitive abilities, including attention. The global decline in cognition and communication that occurred likely contributed to the lack of effectiveness of treatment in Phase I.

Although lexical retrieval training has previously been shown to be effective in participants with different subtypes of primary progressive aphasia, the presence of cognitive decline has also been shown to be a detrimental factor for learning (Beeson et al., 2011; Henry et al., 2013; Newhart et al., 2009). Based on standardized testing, the participants in the previous research studies were less cognitively and linguistically impaired than DL, and began treatment in a milder stage of PPA (Beeson et al., 2011; Henry et al., 2013). Thus, it is reasonable to assume a more positive response to treatment was seen as a result of less impaired abilities at the start of treatment. Thus, the severity of DL's language and cognitive decline in addition to her moderately advanced PPA at the beginning of treatment may have negatively influenced her ability to learn using this impairment-based treatment paradigm. Additionally, the low intensity of the treatment protocol (30 minutes direct treatment per week, plus a total of 30 minutes homework per week) may also be a contributing factor to the lack of treatment effects.

In summary, treatment effects in Phase I were limited. Phase II was subsequently focused on compensation for cognition and language deficits through the use of written and graphic cues in the form of a memory wallet.

Methods: Phase II

Treatment: Phase II

The Memory Aid. To test the effects of a memory wallet on DL's conversational abilities, Phase II involved a modified replication of Bourgeois (1992) and a multiple baseline across behaviours design. Bourgeois (1992) taught the use of a memory wallet with six individuals with probable Alzheimer's disease. The participants demonstrated a range (mild to severe) of naming deficits for both picture description and confrontation naming. They also demonstrated relatively intact oral reading of simple four-to-six word sentences. Results were generally positive for all participants in terms of conversation. At the time of Phase II of the current study in January 2015, DL was 73 years old.

Stimuli. Three topic areas were determined using interview data from conversations with DL, and descriptive knowledge of topics she enjoyed talking about. The topics were personally relevant to DL and included: facts about family members, her hobbies and favourite activities, and her weekly schedule. Five facts for each topic area were chosen using existing knowledge about DL, and photographs corresponding to each topic were taken from family photo albums. In the case that photographs were unavailable, new photographs were found by searching image databases. Sentences describing each picture were composed with simple grammar and sentence structure and were located on the reverse side of the photograph. See the sentences in Table 12 below.

Table 12

Training Sentences

Topic	Sentence	Additional Sentence
"Family"	1. My name is D-. 2. I am married to S-. 3. I have two children, D- and W-. 4. I have five grandchildren. 5. I love my family.	1. I was born in Calgary. 2. We got married in 1965. 3. They both have children. 4. They are growing very fast. 5. They are lots of fun.
"Hobbies"	1. I like to play the clarinet. 2. I like to arrange flowers. 3. I like to do puzzles. 4. I like to listen to music. 5. I like to travel.	1. I take lessons. 2. They are very lovely. 3. They are fun to solve. 4. I go to the symphony. 5. I have been to France.
"Schedule"	1. On Monday, I exercise. 2. On Tuesday, I go for a walk. 3. On Wednesday, I play clarinet. 4. On Thursday, I have speech therapy. 5. On Friday, I exercise again.	1. It keeps me fit. 2. Sometimes in the mall. 3. D- teaches me. 4. It's at U of A. 5. I like planks.

The photographs and sentences were mounted on index cards and placed into a plastic photo album, to comprise one wallet with 15 stimuli, with each topic separated by tabs. Additional sentences for each photograph were composed but were not trained. Instead, these sentences were offered to DL as a prompt for more information.

Baseline Probes. Prior to beginning treatment, three *baseline* probes were conducted to examine DL's performance on all three topics *without* the wallet. The clinician prompted DL to speak about a certain topic, for example, "Tell me about your family." After 10 seconds, the clinician introduced the next topic, until all topics were completed. DL was not interrupted or corrected for unintelligible statements and the clinician did not ask questions or make any comments aside from acknowledgment of statements (e.g., "Oh, that's interesting.") During treatment, the baseline probe procedure was used to conduct an additional five *performance* probes to periodically investigate DL's performance on all three topics without the wallet. Please see the procedure for the probe sessions in Table 13 below.

Table 13

Procedure for Phase II Baseline and Performance Probes

Baseline Probes	
1.	Say, "Tell me about your family" *Wait 10 seconds for response* Say, "Is there anything else you can tell me about your family?" *Wait 10 seconds for response*
2.	Say, "Tell me about your hobbies" *Wait 10 seconds for response* Say, "Is there anything else you can tell me about your hobbies?" *Wait 10 seconds for response*
3.	Say, "Tell me about what you do during the week. Do you have a schedule?" *Wait 10 seconds for response* Say, "Is there anything else you can tell me about what you do during the week?" *Wait 10 seconds for response*

Wallet Probes. Similar to the baseline and performance probes, wallet probes were also conducted for each topic individually. However, in these sessions, the wallet was made available to DL but she was given no cues or assistance in opening it or reading the sentences. The clinician prompted DL with the following statement: "Tell me about [topic]", and asked one question when it seemed DL was finished speaking: "Is there anything else you can tell me about [topic]?" There were six "Family" wallet probes and three wallet probes for each of the "Hobbies" and "Schedule" topics.

Treatment Sessions. Each topic was trained in sequence, beginning with Family, followed by Hobbies and Schedule, during videotaped 45-minute sessions once per week at the

University of Alberta. All three topics were trained in a total of 12 treatment sessions from January to March 2015. Treatment sessions began with the clinician presenting DL with the wallet and introducing the topic for the day. The clinician made note of DL's affect and general behaviour during the sessions. The training procedure was as follows:

1. "You can use this book to help you when I ask questions."
2. "Tell me about your family/hobbies/schedule."
3. If DL reads the sentence, affirm and repeat the sentence for her.
4. If DL reads incorrectly or does not read the sentence, say, "let's read it together" while pointing to each word.
5. After 5 seconds latency, ask "what else can you tell me?"
    a. Present extra sentence typed on the back side of the photograph. For example, "How about, *I was born in Calgary*?"
6. After 5 seconds latency, prompt DL to turn the page.
7. For the rest of the pictures within that topic, say, "Tell me about this picture" and repeat steps 3-6.

Data Analysis. A protocol was designed to code DL's utterances during each baseline, performance, and wallet probe session. As is convention in communication treatment studies, data from probe sessions were analyzed as opposed to data from training sessions, to determine DL's abilities in using and talking about the topics in the wallet without cues or assistance used during the training sessions. Utterance types were coded according to the following protocol: unintelligible statements, non-relevant intelligible statements, relevant intelligible statements directly related to the topic, clinician comment, and silent periods. Relevant utterances were counted as remarks directly related to the topic, as well as intelligible responses to the clinician asking questions about the topics. Non-relevant intelligible statements were also counted. These included utterances that were not directly related to the wallet topics, such as “thank you.” Data including number of relevant, intelligible statements are reported below. The clinician used a loosely scripted conversation, thus, partner communication behaviour was not coded as in Bourgeois (1992).

Data are primarily presented in a descriptive format. Quantitative data include mean frequencies and standard deviations of each variable, specifically, each type of statement made by DL during baseline, performance, and wallet probe sessions. The primary dependent variable was number of intelligible, relevant statements made by DL during probe sessions.

Results: Phase II

Quantitative Data

The number of relevant and irrelevant utterances can be seen in Table 14. During the wallet probe sessions, the wallet was made available to DL but no cues or assistance were given. During the baseline sessions, the wallet was not made available to DL.

Table 14

Number of relevant and irrelevant statements during probes

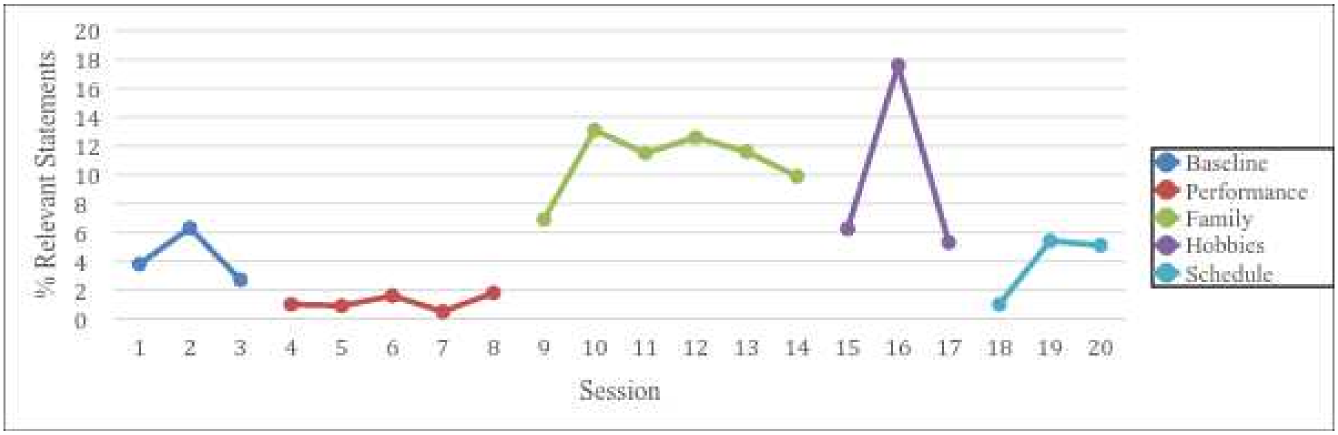
Session	# Relevant Statements	# Irrelevant Statements
Baseline 1	9	22
Baseline 2	5	13
Baseline 3	10	27
Performance 1	3	11

Performance 2	3	8
Performance 3	5	12
Performance 4	1	6
Performance 5	3	6
Family 1	22	24
Family 2	18	5
Family 3	5	0
Family 4	11	3
Family 5	20	10
Family 6	14	4
Hobbies 1	2	1
Hobbies 2	15	7
Hobbies 3	16	13
Schedule 1	1	5
Schedule 2	11	18
Schedule 3	11	10

Percent of relevant utterances. Each utterance was timed to the nearest second, and a total time and percent of relevant content was calculated for each probe based on the length of the session in seconds. These data can be seen in Figure 5 on page 38. DL increased the percentage of relevant statements she made during the Family (Topic 1) and Hobbies (Topic 2) wallet probes when compared to the baseline sessions when she did not have the wallet present. The percent of relevant utterances for the Schedule topic wallet probes is comparable to the baseline sessions.

Figure 4

Percent of relevant utterances in baseline, performance and wallet probes



Reliability. Inter-rater reliability was determined by having a volunteer at the University of Alberta Aphasia Research Lab code DL's utterances within four randomly selected probe sessions (10% of the total). Inter-rater agreement was determined on a per-utterance basis; the student volunteer and the experimenter had to code an utterance identically to be counted as an agreement. Disagreements typically involved the volunteer judging an unintelligible statement as an intelligible one, and due to being unfamiliar with DL's life, marking it as relevant. For example, during one Family probe, DL uttered an unintelligible statement. The volunteer heard a series of paraphasias and interpreted it as the name "Robbie," and thus relevant to the probe. The clinician had knowledge of DL's family and was aware there was no family member named "Robbie," and thus marked this utterance as unintelligible. Such discrepancies were common in these analyses, which contributed to the low reliability scores. All disagreements were resolved via consensus. Inter-rater agreement percentages can be seen in Table 15. The following reliability calculation from McReynolds and Kearns (1983) was used:

$$R = \frac{\#\ Agreements}{\#\ Agreements + \#\ Disagreements} \times 100$$

Table 15

Inter-rater agreement for relevant intelligible utterances

Session Analyzed	Inter-rater Agreement (%)
Baseline Probe #4	22.7%
Baseline Probe #5	31.5%
Family Wallet Probe #4	78.5%
Family Wallet Probe #5	39%
Overall Mean Agreement without consensus	42.9%

Discussion: Phase II

The data for this phase of the study indicate some positive outcomes from treatment. DL did experience some success with conversational ability with regards to intelligible, relevant statements when using the wallet. Her ability to make relevant statements without the wallet did not improve; however, it was observed that her ability to read the sentences accurately with the wallet present allowed her to convey that information to the conversation partner, in this case, the clinician. Based on observation during treatment sessions, the clinician judged that DL had some difficulty reading multi-syllabic words, such as “grandchildren” and “1965,” but her oral reading of 3- to 5-word sentences was good. When evaluating the percent of relevant utterances per probe, it is clear that her relevant utterances increased for the Family and Hobbies topics when she was using the wallet as a supportive communication device. DL’s relevant utterances for the Schedule probes were comparable to the percent of relevant utterances during the Baseline probes. During the Schedule sessions, DL’s demeanour and nonverbal communication suggested that she was not as interested in the topic as she was for the Family and Hobbies topics. The lack of personal photographs for this topic may have contributed to DL's lack of learning, performance, and overall lack of engagement in the topic.

The results for this phase of the study indicate that wallet training on specific topics was beneficial for improving DL's conversational ability when the wallet was present. The results of this study show that training a cognitive-communication aid such as a memory wallet may prove to have positive effects for cognitively impaired individuals and may increase the quality of conversations. DL regularly made comments such as "I love this" when asked if she was enjoying the communication wallet. This positive regard about the wallet is echoic of Bourgeois' (1992) results, in which the researcher reported that participants felt positively about their communication when using the wallet.

General Discussion and Summary

Treatment outcomes have been presented for one individual who initially presented with the logopenic variant of PPA. Prior to treatment, DL presented with marked anomia, overall nonfluent speech, and mildly impaired cognitive skills. She was able to communicate her message to conversational partners while using supported conversation techniques such as writing keywords, rephrasing, and using gestures. The first treatment approach (Phase I) was restitutive and based on providing therapy for DL's specific impairment with word retrieval. Phase I was designed to target lexical retrieval abilities while building on DL's existing orthographic skills. The second treatment approach (Phase II) was a compensatory approach and was designed to enhance DL's conversational ability when talking about topics of importance to her, with the assistance of written and graphic cues in the form of a memory wallet. These approaches have previously been used separately with some positive outcomes in individuals with PPA. As of this writing, the combination of treatment approaches has not been reported on an individual with moderate-severely advanced PPA.

Implications for treatment of degenerative disorders

DL's treatment outcomes were limited. Her cognition declined steadily throughout Phase I of treatment, which reduced the effectiveness of the restitutive, impairment-based approach that was being used. DL was also approximately 5 years into the progression of PPA; at the beginning of treatment, her language was moderately impaired and her cognition was relatively intact with some mild functional deficits. By the end of treatment, approximately 18 months later, DL was moderate-severely impaired in both language and cognitive abilities. According to Rogalski, Cobia, Harrison, Wieneke, Weintraub, and Mesulam (2011), PPA patients experience significant cortical atrophy over two years once the early-middle stage has been reached. This sharp increase in atrophy is responsible for the behavioural changes that are witnessed several years into the progression of PPA. Because DL was approximately 6 years into the progression of her disease at the end of Phase I, and had already reached the middle stage of severity by the beginning of treatment, her decline over the course of this study is consistent with Rogalski et al.'s (2011) findings regarding progression of cortical degeneration and behaviour.

The participant in Beeson et al.'s (2011) study demonstrated relatively intact and stable nonverbal cognition. In this study, the semantically-based treatment approach was effective in increasing the participant's ability to name target items. Additionally, as reported in Henry et al. (2013), the individual with svPPA had no problems with memory or nonverbal cognition, and had noticed language difficulties for just one-and-a-half years. The lexical retrieval hierarchy (upon which the treatment in the current study was based) was effective in training target items in this individual (see page 9 for additional details). In the same study, a participant with lvPPA had begun to notice language impairments five years prior, and also experienced cognitive decline over the course of treatment; however, this participant still experienced good treatment outcomes (Henry et al., 2013). The participant also demonstrated a higher level of naming ability at the beginning of treatment, as shown by a score of 27/60 on the *Boston Naming Test (BNT;* Goodglass & Kaplan, 2001), compared to DL's pre-treatment score of 8/60 on the same test. As discussed on page 30, the above mentioned restitutive approaches to therapy for PPA offer indications that if cognition is relatively spared and the patient is earlier in the progression of the disease, the patient may be more likely to benefit from impairment-based therapy. It is for the reasons discussed above that DL's lexical retrieval treatment outcomes cannot be reliably compared to other studies using similar techniques. Although previous studies have shown maintenance and improvement in individuals with PPA, these studies were done on participants with minimal cognitive decline and less severe language impairments (Beeson et al., 2011; Henry et al., 2013).

In the current study, there were some gains when training the communication wallet in Phase II. With written cues in place, DL was able to utter more relevant, intelligible statements than when the cues were not available (see pages 36-38). These outcomes may indicate that a compensatory approach is more appropriate for a patient in the severe, later stages of neurodegenerative decline. Wallets such as the one that was trained may be taken along with the patient in their daily life, improving the quality of their communication with strategies and cues when needed. For a patient with similar impairments as DL, an increase in independence during daily living activities due to a communication aid may increase overall quality of life. Such compensatory approaches can also benefit caregivers and family members as well, allowing them to enrich or regain some conversational ability with their loved ones.

Future research

It is important to note that the results found in this study may not be applicable to other individuals with PPA. As reported, there have been several studies examining treatment effects for a specific impairment (i.e., lexical retrieval) in individuals with PPA that found positive results. When designing restitutive treatment for individuals with PPA, future studies should include a more in-depth analysis of the chosen stimuli, including phoneme and grapheme similarity to reduce interference that may negatively affect learning. Although the stimuli in the current study were analyzed for other factors that influence learning, phoneme and grapheme similarity were not considered. The individual in the current study was quite far into the progression of her disease when treatment was begun. Future studies should consider this factor, as restitutive, impairment-based treatment approaches may be most effective in individuals who are earlier in the progression of the disease.

In future research and clinical settings, considerations may be made regarding the structure of treatment approaches for individuals with neurodegenerative disorders. These include the rate of cognitive decline and length of time since first developing symptoms. Future studies should also consider monitoring cognitive skills throughout treatment, to ensure that any decline can be accounted for and treatment can be adjusted accordingly. It is important to involve family and other care partners in all aspects of the treatment, to ensure generalization of learning from the treatment sessions to everyday life activities. Similarly, when designing communication wallet treatment, it is critical that the clinicians choose topics that are important to the individuals, and choose personal photographs when available. Having a personal attachment to the wallet can make the treatment more salient and more enjoyable to the participant, as shown by DL's enthusiasm for the topics that were both important to her and accompanied with personal photographs. The communication wallet remains a useful tool for training and improving conversational abilities in individuals with cognitive-communication difficulty, and could be beneficial for individuals with different causes of impairment, such as stroke-induced aphasia and PPA.

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Appendix A

Phase I: Baseline probe stimuli and accuracy

Item	1	2	3
Glass			
Man	✔	✔	✔
Pig			
Plant			
Bowl			
Scissors			
Whistle			
Drum			
Pumpkin			✔
Keys			
Spoon			
Chair	✔		
Zebra			
Bridge			
Fish		✔	
Cow		✔	
Can			✔
Cannon			
Door			
King	✔		
Hair			✔
Knife			
Chimney			
House	✔		

Item	1	2	3
Foot			✔
Cup			
Camel			
Soap			
Spider			
Top			
Horse			
Duck		✔	✔
Brush			
Anchor			
Gloves			
Dog			✔
Scarf			
Couch			
Well			
Pirate			
Dragon			
Clock			
Fork	✔		
Church			
Ring			
Zipper	✔		
Lamp			
Bed			

Phase I: Performance probe stimuli and accuracy

Item	1	2	3	4	5	6	7	8	9	10	11	12
House												
Glass				✔								
Bed												
Horse												
Fork												
Chair					✔							
Bowl												
Ring		✔										

Top												
Scarf												
Cup												
Couch												
Gloves												
Hair					✔							
Lamp												
Plant												
Keys			✔				✔	✔	✔	✔		✔
Clock												
Soap												
Spoon												
Well												
Pig												
Drum												
Church												
Brush												
Door	✔											
Cow		✔		✔					✔			
Knife												
Bridge												
Foot			✔		✔							

Appendix B

Pre- and Post-treatment behavioural assessment scores

Test	Category / Subtest	Pre-treatment raw score	Pre-treatment percent	Post-treatment raw score	Post-treatment percent	Change
WAB-R (Kertesz, 2009)	Spontaneous Speech	10/20	50%	6/20	30%	-20%
	Auditory Verbal Comprehension	7.45/10	75.5%	3.05/10	30.5%	-45%
	Repetition	6.3/10	63%	1.5/10	15%	-48%
	Naming	3.1/10	31%	0.7/10	7%	-24%
	Aphasia Quotient		53.7		22.5	-42%
BNT (Goodglass & Kaplan, 2001)	Naming	8/60	13.3%	2/60	3.3%	-10%
PPT (Howard & Patterson, 1992)	Semantic knowledge	43/52	82.6%	-	-	-
ABRS (Beeson & Rising, 2010)	Regularly spelled words	31/40	77.5%	31/40	77.5%	0%
	Irregularly spelled words	28/40	70%	27/40	67.5%	-2.5%
	High frequency words	28/40	70%	31/40	77.5%	+7.5%
	Low frequency words	31/40	77.5%	28/40	70%	-7.5%
	Total	118/160	73.7%	117/160	73.1%	-0.01%
RBCA (LaPointe & Horner, 1998)	Word-Visual	10/10	100%	-	-	-
	Word-Auditory	10/10	100%	-	-	-

	Word-Semantic	9/10	90%	-	-	-
	Functional reading	4/10	40%	-	-	-
	Synonyms	6/10	60%	-	-	-
	Sentence-Picture	8/10	80%	-	-	-
	Morpho-syntax	5/10	50%	-	-	-
	Lexical decision	20/20	100%	-	-	-
	Oral Reading – Words	30/30	100%	-	-	-
	Oral Reading – Sentences	30/30	100%	-	-	-
RCPM (Raven, Raven, & Court, 2003)	Nonverbal cognition	19/37	51.3%	17/37	45.9%	-5.4%
ABCD (Bayles & Tomoeda, 1993)	Story retell – immediate	8/17	47%	-	-	-
	Story retell – delayed	7/17	41%	-	-	-
	Word learning – free recall	7/16	44%	-	-	-
	Word learning – cued recall	3/16	19%	4/16	25%	+6%
	Word learning – total recall	10	31%	-	-	-
	Word learning – recognition	47/48	98%	26/48	54%	-44%

Appendix C

Example of CART weekly homework – Phase I

DOOR

LAMP

CHAIR