Summer 2013

Effects of Semantic + Multimodal Communication Program for Switching Behavior in Severe Aphasia

Shannon A. Carr

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EFFECTS OF SEMANTIC + MULTIMODAL COMMUNICATION PROGRAM FOR
SWITCHING BEHAVIOR IN SEVERE APHASIA

A Thesis
Submitted to the John G. Rangos Sr.
School of Health Sciences

Duquesne University

In partial fulfillment of the requirements for
the degree of Master of Science

By
Shannon A. Carr

August 2013
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Shannon A. Carr

2013
EFFECTS OF SEMANTIC + MULTIMODAL COMMUNICATION PROGRAM FOR SWITCHING BEHAVIOR IN SEVERE APHASIA

By

Shannon A. Carr

Approved June 14, 2013

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ABSTRACT

EFFECTS OF SEMANTIC + MULTIMODAL COMMUNICATION PROGRAM FOR SWITCHING BEHAVIOR IN SEVERE APHASIA

By
Shannon A. Carr

August 2013

Thesis supervised by Sarah E. Wallace, Ph.D.

Treatment for severe aphasia includes teaching alternative modalities to improve communicative effectiveness by circumventing deficits in verbal expression. Traditionally, alternative communication modalities are trained separately to augment or replace verbal output. However, adults with aphasia often have executive function deficits, specifically deficits in cognitive flexibility, which affect the communicative flexibility of the individual. The result is an inability to switch to a previously learned alternative modality when a communication breakdown occurs. This study explored a combined semantic + multimodal communication program (S+MCP) for an individual with severe aphasia and coexisting semantic deficits. The effect of S+MCP on his ability to switch between modalities when an initial communication attempt failed was examined during a referential communication task and administration of the CADL-2
with modified scoring. The participant demonstrated increased switching behavior between modalities during both tasks, and increased use of combined modalities (e.g., verbal plus gesture).
ACKNOWLEDGEMENTS

We cannot plan for the variety of paths that are ahead of us, but we can decide the paths that we choose to follow. This project was an unforeseen path in my education that I could not have predicted. I am honored to have the assistance and support that has made this project possible.

Dr. Wallace, I want to thank you for your dedication to this project. You have introduced me to the world of research and I am grateful for all of your support.

Dr. Kimelman and the Duquesne University Speech-Language Pathology Department, thank you for your support for this project. I am appreciative of everyone who had helped me develop my skills as a clinician so that I could learn to ask questions in pursuit of this research.

Thank you to my colleagues that have assisted me with the study in any capacity: Jennifer Kahle, Amy Saraceno, Danielle Moss, and Christin Graham.

Ayodeji Kayode, thank you for encouraging me expand my horizons to apply to Duquesne and then to pursue a thesis. Your support during this project has been effective in keeping me grounded and set on this goal.

Finally, thank you to my friends and family for their unwavering support over the years.
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COMMUNICATION DEFICITS IN APHASIA

Aphasia is an acquired, multimodal disorder characterized by a breakdown in the ability to formulate, retrieve or decode the arbitrary symbols of language that is not due to a cognitive, sensory, or motor deficit (McNeil & Pratt, 2001). A hallmark characteristic of aphasia is difficulty formulating and retrieving language resulting in word retrieval impairments. Word retrieval is the process of translating a stimulus into a conceptual representation, retrieving the name of the stimulus, and articulating that name (Dell, Lawler, Harris, & Gordon, 2004). According to a model of lexical retrieval hypothesized by Dell et al. (2004), retrieval of an object name is a two-step process. The first step is lemma access, which is the connection of a concept to a semantic representation of a word, also known as the lemma. Lemma access begins with activation of semantic features of a concept, and then spreads until the most active unit is selected, such as a noun. The second step, phonological access, consists of connecting the lemma to the phonological form of the word which results in verbal expression. Phonological access begins with activation of the targeted word, then spreads to activate the phonemes of that word for verbal expression. This model is represented in Figure 1. Errors in word retrieval can occur within either, or both, steps of lexical retrieval. Deficits within the first step, semantic representation, result in the activation of non-target concepts. Deficits within the second step, phonological access, result in activation of phonemes unrelated to the target word. As a result, deficits in either step of lexical retrieval will result in difficulty communicating a concept verbally.
Figure 1. Visualization of a model of lexical retrieval by Dell et al. (2004). The first step, lemma access, connects the stimulus to the semantic representation of the word. Then, phonological access activates the phonemes for verbal communication of the concept.

Intervention to improve communicative effectiveness for people with deficits in step 2 of the model of lexical access can focus the restoration of verbal communication or instruction in alternative communication modalities. The aim of instruction in the use of alternative modalities such as writing, drawing, gesturing, pointing to a communication board or using high technology devices is primarily to circumvent verbal communication deficits, thereby improving overall communicative effectiveness. Typically, alternative modalities are taught separately in an attempt to improve performance communicating in a particular modality, such as gesturing. Previous studies investigated the use of alternative communication modalities such as drawing (Lyon & Helm-Estabrooks, 1987; Sacchett, Byng, Marshall, & Pound, 1999), writing (Beeson, Rising, & Volk, 2003; Robson, Pring, Marshall, Morrison, & Priat, 1998), gesturing (Damuller & Goldenberg,
pointing to a communication board (Calculator & Luchko, 1983), and using high technology devices (Hough & Johnson, 2009; Johnson, Hough, King, Vos, & Jeffs, 2008). However, programs to teach multiple communication modalities provide people with aphasia with a communication system in attempt to improve the overall communicative effectiveness of the individual (Rodriguez, Raymer, & Rothi, 2006).

Purdy, Duffy, and Coelho (1994) examined the efficacy of a multimodal program to teach the use of the following communication modalities: pointing to a communication board, gesturing and verbalizing. All modalities were taught separately to enhance the participants’ use of multiple modalities to communicate. Purdy et al. (1994) observed that participants did not attempt to switch to an alternate communication modality when verbal output failed. Results indicated that the ability to switch between modalities may have affected the use of alternate modalities to communicate a message. Purdy et al. (1994) suggested that deficits in executive function may affect the ability of people with aphasia to switch between alternate modalities.

**Executive Function Deficits in People with Aphasia**

People with aphasia exhibit impairments in executive functions in addition to language impairments (Frankel, Penn, & Ormond-Brown, 2007; Glosser & Goodglass, 1990; Helm-Estabrooks, 2002; Purdy, 1993). Purdy (2002) examined the executive function skills of people with aphasia as compared to people without aphasia on nonverbal tasks designed to measure performance in two areas of executive function: goal-directed planning and cognitive flexibility. Results indicated that people with
aphasia may demonstrate impaired performance on executive function tasks with decreased in accuracy, efficiency, and speed of completion. Cognitive flexibility deficits were identified as the primary impairment that affected the performance of people with aphasia in this study. Researchers suggested that executive functions may play a role in communicative performance. These results are consistent with Helm-Estabrooks’ (2002) conclusion that deficits in executive function inhibit the ability to plan intentional communication and adjust to environmental conditions, thus impacting functional communication skills.

Cognitive flexibility includes multiple cognitive processes such as generating multiple ideas, modifying behavior based on situational changes, and considering alternative responses (Eslinger & Grattan, 1993). One aspect of functional communicative effectiveness that is affected by cognitive flexibility is the ability to switch among learned communication modalities. In other words, communicative flexibility, or the ability to monitor and modify communication, is an important part of communicative effectiveness. Purdy (2002) suggested that some people with aphasia have an overall communicative flexibility deficit that affects the ability to respond to situational or environmental changes, impacting overall communicative effectiveness. These suggestions are similar to Purdy et al. (1994) in which cognitive flexibility played a role in the participants’ ability to communicate effectively because they were unable to switch to an alternate modality when a communication breakdown occurred.

One possible reason for the lack of switching behavior was the intervention program used by Purdy et al. (1994). This treatment taught communication modalities separately, not explicitly addressing the need to switch modalities when a communication
attempt failed. These findings suggest that competence in the use of alternative communication modalities may not be sufficient to promote switching behavior. Effective programs to improve switching behavior when a communication breakdown occurs are needed to improve the overall communicative effectiveness of a person with aphasia. For example, if the person with severe aphasia has difficulty verbally expressing a concept, instruction in alternative communication modalities and switching behavior may improve the person’s ability to switch to a nonverbal modality, such as writing or drawing.

**Measuring Switching Behavior in Aphasia**

Purdy and Koch (2006) examined cognitive flexibility as it related to the evaluation of modality usage by people with aphasia. The aim of the study was to compare the cognitive flexibility performance of people with aphasia on the *Wisconsin Card Sorting Test (WCST)* (Grant & Berg, 2003) and the *Communicative Activities of Daily Living (CADL)* (Holland, 1980) with modified scoring to determine if scores correlated. The WCST is a standard test of cognitive flexibility in which participants sort stimulus cards based on rules. During administration, sorting rules change and the participant’s ability to switch to the new rules are analyzed based on accuracy and time required to switch. The modified CADL score was obtained by incorporating all response modalities, both verbal and nonverbal, used by the participant during the assessment. If an initial communication attempt failed, the ability of the participant to switch to an alternate modality was analyzed, resulting in a communicative flexibility score. Results indicated that the communicative flexibility score obtained from administration of the CADL with modified scoring significantly correlated with the WCST score, suggesting
that the *CADL* with modified scoring can be used to measure cognitive flexibility. However, compared to the *WCST*, the *CADL* with modified scoring can assist in obtaining cognitive flexibility measures within communicative contexts, or communicative flexibility. More specifically, the *CADL* with modified scoring provides information about the impact of cognitive flexibility on switching behavior when communication breakdown occurs on a communicative task.

To further examine scores obtained from the *CADL* with modified scoring, Purdy and Koch (2006) determined participants’ cognitive flexibility scores as determined by the *CADL* with modified scoring and the participants’ performance on a referential communication task. Participants who had switched modalities when a communication attempt failed during administration of the *CADL* were more likely to switch during a referential communication task. Results suggest that the cognitive flexibility score obtained from the *CADL* may predict an individual’s communicative flexibility defined as the ability to switch to another modality on a communication task when an initial communication attempt fails.

Chiou and Kennedy (2009) examined the switching ability of people with aphasia as compared to people without aphasia on tasks requiring minimal-language processing in which participants switched between 1-step rules (e.g., “Do not respond to O”) presented visually or auditorally on Go/No-Go tasks. Results indicated that people with aphasia demonstrate impaired ability to switch between rules as shown through slower response times and less accurate responses than people without aphasia. The researchers hypothesized that the participants’ language abilities may have impacted their ability to
understand the instructions of the task. Results also suggested that switching behavior impacts a person’s ability to use a variety of strategies to communicate.

**Treatment to Improve Switching Behavior in Aphasia**

Successful switching to alternative communication modalities during communication tasks may be impacted by the person with aphasia’s cognitive flexibility (Purdy et al., 1994). To improve the use of alternative modalities, treatment programs may need to teach the use of multiple modalities and switching behavior simultaneously to improve the overall communicative effectiveness of people with aphasia.

Yoshihata, Watamori, Chujo, & Masuyama (1998) investigated a procedure for teaching switching behavior for multimodal communication in adults with severe nonfluent aphasia. The participants in the study were taught to use two compensatory communication modalities to increase nonverbal modality interchange skills. In contrast to Purdy et al. (1994), in which modality usage was taught separately, the program occurred in three stages with emphasis on integration of modalities. In the first stage, participants received instruction in gesturing and drawing. In the second stage, the participants were taught to use gesturing and drawing interchangeably in a request situation. In the final stage, researchers examined the participants’ ability to switch between and use gesturing and drawing in communicative situations with communication partners. The communication partner played an important role in this study, as for some items he or she provided the people with aphasia with an incorrect response even if the correct modality was produced to explicitly measure switching behavior. This approach to examining switching behavior may provide explicit opportunities to demonstrate
communicative flexibility that can be implemented in future studies. The study provided evidence that some people with severe nonfluent aphasia may be impaired in their ability to switch modalities when communication breakdown occurs with a communication partner.

The study completed by Yoshihata et al. (1998) exclusively taught the use of two nonverbal communication modalities. Purdy and VanDyke (2011) examined a program to teach multimodal communication and improve switching behavior among a variety of modalities including gesturing, writing, pointing to a communication board, and speaking. This case study investigated the effect of teaching of communication modalities in an integrated manner to improve switching behavior. The researchers suggested that teaching verbal and nonverbal modalities in this combined manner may increase switching behavior and may carry over to a referential communication task. Two participants, one with severe nonfluent aphasia and another with severe fluent aphasia, were taught to use multiple modalities. Results indicated that a multimodal communication program (MCP) improved the ability of the participants to switch modalities during a referential communication task, although further examination of this intervention is needed.

While treatment improved switching behavior for both participants, the participant with severe fluent aphasia demonstrated limited improvement following MCP (Purdy & VanDyke, 2011). This participant had a semantic impairment as determined by his score on the Pyramids and Palm Trees test (PPT) (Howard & Patterson, 1992). Purdy and VanDyke (2011) suggested that semantic impairment may limit the improvement of switching behavior following MCP. The investigators provided the participant with brief
semantic treatment that improved his overall verbal naming abilities, but resulted in fewer opportunities to demonstrate switching behavior during the referential communication task. However, his overall communicative effectiveness increased following both multimodal and semantic treatments. These results indicate that the participant demonstrated impaired ability to complete step 1 in lexical retrieval, lemma access, impacting his ability to access the correct concept to be communicated (Dell et al., 2004). Additional research is needed to determine how best to address deficits in both steps of lexical processing. One possibility is to combine the semantic and multimodal communication intervention to further integrate verbal and nonverbal communication modalities. A combined semantic and multimodal communication program will address deficits in step 1 of the model of lexical access as well as deficits in step 2 of lexical access, thus improving the overall effectiveness of a multimodal communication program, and the communicative effectiveness of the participants (Figure 2).

![Diagram of S+MCP treatment aims]

*Figure 2. Model of S+MCP treatment aims. S+MCP would treat lemma access, while circumventing deficits in phonological access through the use of alternative communication modalities to improve switching behavior.*
Purpose and Research Questions. The purpose of this study was to examine the effects of a combined semantic + multimodal communication program (S+MCP) on the ability to switch among modalities for a person with severe aphasia and coexisting semantic deficits. Specifically, this study aimed to answer the following questions:

1. Does implementation of S+MCP affect the ability of an individual with severe aphasia and coexisting semantic deficits to switch among communication modalities when an initial communication attempt fails while completing a referential communication task (RCT)?

2. Does implementation of S+MCP affect the ability of an individual with severe aphasia and coexisting semantic deficits to switch among communication modalities when an initial communication attempt fails during administration of the CADL-2 with modified scoring?
CHAPTER II

METHODS

Experimental Design

The researcher employed an experimental single-participant multiple baseline across stimuli (word lists) design. S+MCP was conducted across two phases (Treatment Phase 1 and Treatment Phase 2), with six treatment sessions during each phase. During Treatment Phase 1, S+MCP was completed with Treated list 1, while Treated list 2 and Untreated list were not treated. All three lists were probed to examine switching behavior during a referential communication task (RCT) completed at the beginning of each session. During Treatment Phase 2, S+MCP was completed using Treated list 2 while Treated list 1 and Untreated list remained untreated. Again, all words lists were probed for switching behavior during the RCT completed at the beginning of each session.

Participant

Participant recruitment began following approval of the research protocol by the Duquesne University Institutional Review Board. Recruitment of potential participants was conducted through the Duquesne University Speech-Language and Hearing Clinic. Clinical instructors within the Adult Neurogenic Program distributed recruitment flyers (Appendix 1). One person with aphasia was recruited for participation.

A 77-year-old retired, college-educated male participated in the study. He sustained a single left hemisphere stroke 15 months prior to participating in the study and had no previous history of neurological or learning impairment. Prior to the stroke, the participant was right-handed. Secondary to right hemiparesis resulting from his stroke, he
used his left hand for writing and drawing tasks. The participant lived at home with his wife and was ambulatory with the use of a cane. His demographic information is found below in Table 1.

Table 1. Participant demographic information.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>77 years old</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
</tr>
<tr>
<td>Time Post Stroke</td>
<td>15 months</td>
</tr>
<tr>
<td>Education</td>
<td>16 years</td>
</tr>
<tr>
<td>Former Occupation</td>
<td>Engineer</td>
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<tr>
<td>Residential Status</td>
<td>Lives with Spouse</td>
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<td>Native Language</td>
<td>American English</td>
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<tr>
<td>Language Spoken</td>
<td>American English</td>
</tr>
<tr>
<td>Dominant Hand Prior to Stroke</td>
<td>Right</td>
</tr>
<tr>
<td>Affected Hand</td>
<td>Right</td>
</tr>
<tr>
<td>Ambulatory Status</td>
<td>Right Hemiparesis; Ambulatory with use of cane</td>
</tr>
</tbody>
</table>

The participant spoke American English as his first and primary language, passed hearing screenings at 25dB for frequencies of 500 Hz, 1000 Hz, and 2000Hz, and passed a vision screening. The vision screening consisted of standard letter paper with nine rows of three names each (27 names total) printed in 36-point Arial font, the same font that was printed on the 4X6 inch index cards used during the semantic treatment (refer to materials for details), to determine if the participant had the visual acuity to see the stimuli used in treatment (Appendix 2). He accurately circled his name each time it appeared on the page (5 times total). The participant had a diagnosis of chronic severe global aphasia as indicated by a Western Aphasia Battery—Revised (WAB-R) Aphasia Quotient (AQ) (Kertesz, 2006) of 19.7 out of 100. He presented with fluent aphasia
characterized by 5 to 6 word phrases with marked use of jargon and automatic speech. He was not enrolled in speech therapy for the duration of the study.

As criterion for inclusion in the study, the three-picture version of the *Pyramids and Palm Trees Test (PPT)* (Howard & Patterson, 1992) was administered to document the participant’s semantic impairment. A significant semantic impairment was defined as a raw score below 40 out of a possible 52. Because the *PPT* manual does not define raw scores for severity of semantic impairment, the researcher determined this cutoff score for participation in the study based on Purdy and VanDyke (2011), of which the participant with a semantic impairment possessed a raw score below 40 on the *PPT*. That participant completed an additional semantic treatment because semantic impairment may have impacted the effectiveness of a MCP (Purdy & VanDyke, 2011). The participant in the current study met the criteria for inclusion, obtaining a *PPT* raw score of 28 out of a possible 52. The participant’s raw scores on standardized tests administered during Baseline sessions can be found in Table 2.

*Table 2. Participant’s Raw Scores on Standardized Assessments.*

<table>
<thead>
<tr>
<th>Western Aphasia Battery—Revised (Aphasia Quotient)</th>
<th>19.7/100</th>
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<tr>
<td>Spontaneous Speech Score</td>
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<tr>
<td>Auditory Verbal Comprehension Score</td>
<td>3.15/10</td>
</tr>
<tr>
<td>Repetition Score</td>
<td>0.4/10</td>
</tr>
<tr>
<td>Naming and Word Finding Score</td>
<td>0.3/10</td>
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<table>
<thead>
<tr>
<th>Communicative Activities of Daily Living-2</th>
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<tbody>
<tr>
<td>Baseline 1</td>
<td>35/100</td>
</tr>
<tr>
<td>Baseline 2</td>
<td>42/100</td>
</tr>
<tr>
<td>Baseline 3</td>
<td>40/100</td>
</tr>
</tbody>
</table>

| Pyramid and Palm Trees Test (3-Picture Version)  | 28/52    |

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<thead>
<tr>
<th>Psycholinguistic Assessment of Language Processing in Aphasia</th>
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<tr>
<td>Subtest 47: Spoken Word Picture Matching</td>
<td>19/40</td>
</tr>
<tr>
<td>Subtest 48: Written Word Picture Matching</td>
<td>16/40</td>
</tr>
<tr>
<td>Test</td>
<td>Score</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Subtest 51: Word Semantic Association—High Imageability Words</td>
<td>4/15</td>
</tr>
<tr>
<td>Reading Comprehension Battery for Aphasia</td>
<td></td>
</tr>
<tr>
<td>Subtest I: Word—Visual</td>
<td>6/10</td>
</tr>
<tr>
<td>Subtest II: Word—Auditory</td>
<td>6/10</td>
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<tr>
<td>Cognitive Linguistic Quick Test</td>
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<td>Clock Drawing Subtest</td>
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<tr>
<td>Symbol Trails Subtest</td>
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<tr>
<td>Forward</td>
<td>4/16</td>
</tr>
<tr>
<td>Backward</td>
<td>4/16</td>
</tr>
<tr>
<td>Raven’s Coloured Progressive Matrices</td>
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</tr>
</tbody>
</table>

Materials

Study materials included formal assessments and study stimuli. The researcher administered formal assessments to characterize the participant’s initial communication, semantic abilities, reading comprehension and cognitive abilities prior to treatment. A select number of assessments were administered post-treatment to measure change.

**Formal Assessments.** Formal assessments included the *Western Aphasia Battery-Revised* (*WAB-R*) (Kertesz, 2006), *Communicative Activities of Daily Living-2* (*CADL-2*) (Holland, Frittali, & Fromm, 1999), *PPT* (Howard & Patterson, 1992), Subtest 47, 48, and 51 of the *Psycholinguistic Assessment of Language Processing in Aphasia* (*PALPA*) (Kay, Lesser, & Colthart, 1992), Subtests I and II from the *Reading Comprehension Battery for Aphasia-Second Edition* (*RCBA-2*) (LaPointe & Horner, 1998), the Clock Drawing and Symbol Trails subtests of the *Cognitive Linguistic Quick Test* (*CLQT*) (Helm-Estabrooks, 2001), the Spatial Span subtest of the *Wechsler Memory Scale-Third Edition* (*WAIS-III*) (Wechsler, 2003), and the *Raven’s Coloured Progressive Matrices* subtest of the *WAB-R* (Kertesz, 2006).
**Western Aphasia Battery—Revised.** The researcher obtained a WAB-R Aphasia Quotient (AQ) to describe the participant’s aphasia profile. The WAB-R is a test designed to assess language function of adults to determine the presence, degree and type of aphasia. An AQ was obtained through administration of spontaneous speech, auditory comprehension, repetition, and naming and word finding tasks of the test in order to classify aphasia type and severity.

**Communicative Activities of Daily Living-2.** Standard administration of the CADL-2 provided information about the participant’s communicative skills in the areas of reading, writing, social interactions, divergent communication, contextual communication, nonverbal communication, sequential relationships, and humor and absurdity. The researcher evaluated the participant’s performance on the CADL-2 with modified scoring to determine the participant’s communicative flexibility during functional communication tasks. As defined by Purdy and Koch (2006), the CADL-2 communicative flexibility score was derived using 21 test items that required the use of expressive language. Items that assessed the participant’s receptive communication skills were omitted. Modality usage on the first and second communication attempt (verbalizing, gesturing, pointing, writing and drawing) for each item were recorded. Pointing was accepted as a communication modality in lieu of a communication board, which was provided during the RCT probe (described below). If the participant’s initial communicative attempt failed, it was considered an opportunity to switch modalities. For example, if the participant produced an unsuccessful initial communication modality, such as verbalizing, it was considered an opportunity to switch modalities. If he then
produced an alternate communication modality as a second communication attempt, such as gesturing, it was recorded as a successful modality switch.

Purdy and Koch (2006) used the CADL-2 modified scoring to produce a single score, a communicative flexibility score. Testing completed in this study produced three scores: (1) A communicative flexibility score, (2) The accuracy of initial modality production, and (3) The accuracy of the second modality production. The communicative flexibility score was derived by calculating the ratio of the total number of successful switches to the number of opportunities to switch. Following each communication attempt, the accuracy of initial modality production was measured. When the participant produced a second communication attempt, the accuracy of the second modality production was measured. An accurate use of the initial and second modality was defined as an attempt that was understood as a correct use of the modality by the administrator and a secondary observer who was familiar with communication modalities and aphasia.

*Pyramids and Palm Trees Test.* The three-picture version of the PPT was administered to evaluate the participant’s semantic deficits as criterion for participation in the study. A cutoff score below 40 out of 52 for participation in the study was determined based on Purdy and VanDyke (2011). Given a black and white line drawing representing a target item, the participant identified which of two other line drawings was semantically related to the target. The PPT evaluated the participant’s ability to access semantic and conceptual information from pictures to determine the level of difficulty the participant had in accessing semantic information.

*Psycholinguistic Assessment of Language Processing in Aphasia.* The researcher obtained detailed information regarding the participant’s language abilities
through administration of three subtests of the PALPA: Subtest 47, Subtest 48, and Subtest 51. Subtest 47: Spoken Word Picture Matching assessed semantic comprehension of auditory stimuli. The participant selected a picture following verbal presentation of the item name by the researcher from an array of five pictures (the target and four foils) for a total of 50 words. Subtest 48: Written Word-Picture Matching assessed semantic comprehension of written stimuli. The participant chose a corresponding picture from an array of five pictures (one target and four foils) given orthographic representation for a total of 50 words. Subtest 51: Word Semantic Association: High Imageability Words assessed the participant’s ability to select a word semantically related to another orthographically presented word. The participant read a word silently and selected a semantically associated word related to the target word from an array of four words (one target and three distractors) for a total of 20 items.

*Reading Comprehension Battery for Aphasia-Second Edition.* Due to the inclusion of a written component in this treatment, the researcher administered Subtest I: Word-Visual and Subtest II: Word-Auditory of the RCBA-2 to assess the participant’s reading comprehension of single words. Written stimuli of target words were provided during the semantic treatment as part of S+MCP; however, the treatment tasks did not specifically require single word reading comprehension. Instead, the researcher read the written words aloud while presenting them to the participant during treatment. Characterizing the participant’s single word reading comprehension may have assisted in interpreting his response to treatment, but was not included as criteria for participation on the study.
**Cognitive Linguistic Quick Test.** The participant’s responses to the Symbol Trails and Clock Drawing subtests of the CLQT were used to describe his cognitive abilities. The Symbol Trails subtest of the CLQT measured visuospatial and executive function skills, particularly planning and cognitive flexibility as shown through creating a trail on a page following alternating shapes of increasing size. The Clock Drawing subtest of the CLQT was used as a measure of visuospatial and executive function skills. The participant drew numbers and hands on a blank clock according to an instructed time.

**Wechsler Memory Scale-III.** The Spatial Span subtest of the WMS-III was used as a relative measure of the participant’s visual nonverbal working memory. The subtest consisted of a stimuli board containing a staggered pattern of raised white squares. The researcher tapped the squares in a sequence and the participant attempted to mimic the sequence. Each subsequent trial increased the number of tapped squares until the participant was unable to mimic the sequence for three consecutive trials of increasing complexity. Both the forward and backward portions of the subtest were administered. The score obtained on this subtest was a control measure for the study. Specifically, the researcher hypothesized that the Spatial Span subtest score would not change as a result of the intervention protocol because S+MCP was designed to target modality production and switching behavior, not to improve working memory skills.

**Raven’s Colored Progressive Matrices.** Additionally, the participant completed the Raven’s Colored Progressive Matrices subtest of the WAB-R to measure cognitive skills, specifically nonverbal visual problem solving. The Raven’s Colored Progressive Matrices is a 30 item nonverbal multiple-choice test in which the participant chose an option that best completed a presented visual pattern.
**Study Stimuli.** Study stimuli included 30 target words separated into three word lists, with each target word represented by three sets of images. Additionally, the researcher provided index cards containing orthographic representation of the target word and semantic features during semantic treatment. The participant had access to a communication board and marker and paper as needed during the study.

**Target Words.** Thirty target nouns commonly used in American English were selected for the study. All words were selected from high or mid-frequency occurring words according to Francis and Kucera (1982). These words were randomly divided and balanced into three lists of ten words each. The researcher balanced the word lists based on factors that affected the ease with which alternative modalities were produced, including the number of syllables, ease of gesture production (one or two handed), and number of steps needed to draw the item. Each word list contained a similar number of one, two, or three syllable words resulting in 22-24 syllables per list. All lists contained four words that required two-handed gestures and six words requiring one-handed gestures. However, words requiring a two-handed gesture were modified to be produced one-handed due to the participant’s hemiparesis. Each list also required 24 total steps to draw the items on the list. These factors were identified and measured by the researcher with confirmation from an experienced speech-language pathologist familiar with multimodality interventions. Any discrepancies were resolved prior to final list selection.

Treated list 1 and Treated list 2 received treatment during Treatment Phase 1 and Treatment Phase 2, respectively. Untreated list remained untreated throughout the duration of the study. During each treatment phase, switching behavior for all word lists was probed at the beginning of each session using the RCT.
Images. Each of the 30 target nouns were represented visually by three sets of images (Figure 3). Each image was a photograph or line drawing without a background or any extraneous details. One set of 30 colored line drawings was used during S+MCP treatment sessions and by the communication partner during the RCT (as described in procedures)(Figure 3a). A second set of 30 colored line drawings (Figure 3b) was used to create one of the three communication boards (as described below). A third set of 30 color photographs representing all target words was used by the participant during the RCT probe (Figure 3c). The colored line drawings were derived from Rossion and Pourtois’s (2004) modified Snodgrass and Vanderwart (1980) drawings, as well as similar drawings found on the Internet.

![Figure 3. Example of images used in the study. One set of colored line drawings (3a) were used during treatment sessions and by the communication partner during the RCT. Colored line drawings (3b) were used to create the communication boards. A set of photographs (3c) were used by the participant during the RCT.](image)

Index Cards. During the semantic treatment (see procedures), the researcher used 4X6 inch white index cards containing text representations of treated words (Treated list 1 and Treated list 2) and semantic features. The text on each index card was printed in black 36 point Arial font. For each target word, there were 10 index cards used during
treatment. One index card contained text representation of the target word. These index cards were placed underneath the colored line drawing during semantic treatment. Three index cards with text representations of semantic features were used for each semantic feature treated, with one related feature and two foils. Three feature types were presented during semantic treatment: category, location, and physical property. For example, a single index card represented the word ball. Three related semantic features were paired with the target, each consisting of text representation of a feature (e.g. toy, outside, round), while six were unrelated foils (Figure 4). Each word targeted during treatment (20 words total) was paired with these 10 index cards, with a total of 120 index cards used during semantic treatment.

Figure 4. Example of related and semantic features provided during semantic treatment for a stimulus item (ball).

The features were used during the semantic treatment to provide the participant with an array of three choices for the sorting task. The researcher and another speech-
language pathologist familiar with semantic features determined the features based on
data described by McRae, Cree, Seidenberg, and McNorgan, (2005).

**Communication Stimuli.** The participant was provided with paper and a pen
during Baseline, Treatment, and Post-Intervention sessions. Three communication
boards, each representing one word list (Treated list 1, Treated list 2, and Untreated list)
were used during Baseline, Treatment Phase 1, RCT probe 1-15 and Post-Intervention
sessions during the modality analysis. Each communication board consisted of two
horizontal rows of five items each (10 items total) printed on standard letter paper with
landscape orientation. Images used on the communication boards were colored line
drawings described above (Figure 5).

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<thead>
<tr>
<th>Image 1</th>
<th>Image 2</th>
<th>Image 3</th>
<th>Image 4</th>
<th>Image 5</th>
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*Figure 5. Example of a communication board used during the study.*
Procedures

Baseline Sessions. The participant completed five Baseline sessions. The following formal assessments were each administered once and were distributed across four Baseline sessions: WAB-R, PALPA, PPT, the Clock Drawing and Symbol Trails subtests of the CLQT, RCBA Subtest I and II, and the WMS-III Spatial Span subtest. The CADL-2 was administered three times across three of the five Baseline sessions, to determine that the participant demonstrated stability in his switching behavior as measured by the modified scoring system. Stability during the CADL-2 and RCT (described below) was defined as consistent or declining switching performance across three or six consecutive Baseline sessions, respectively. Because no established criterion is available for session to session variability related to switching behavior during the CADL-2, consistent performance was defined as stable by the researcher and two speech-language pathologists familiar with multimodality treatments for aphasia.

Referential Communication Task. In addition to the formal assessments, the RCT task was completed using all 30 words during each of the five Baseline sessions. The RCT was used to assess the participant’s switching behavior and determine his three most commonly used communication modalities. These three most commonly used modalities were targeted during the treatment phases of the study and probed in RCT tasks. The participant completed a sixth RCT Baseline probe prior to the first treatment session.

The RCT involved the researcher, the participant, and a communication partner blind to whether words were treated or untreated. The communication partner had access
to a randomized list of all 30 treated and untreated words. The list indicated 15 (5 from each word list) randomly selected items to serve as words which the communication partner would provide an incorrect item to the participant to create opportunities to demonstrate switching behavior. A new randomized list was generated for each RCT trial. At the beginning of each RCT probe, the participant received the following instruction: “I am going show you a picture. The communication partner has a similar picture. You need to make a match. To create a match, you will ask her for the picture in any way you can. She will give you the wrong picture if she misunderstands. You can help her understand.” The researcher presented a photograph depicting a single target word to the participant. The communication partner was unable to see the target word photograph. Pen, paper, and a communication board were available to the participant for communication attempts when appropriate.

During Baseline and Treatment Phase 1, the researcher provided the participant with augmented input in the form of gestures to assist with the participant’s comprehension of the instructions. During Treatment Phase 2, the participant was provided with additional augmented input in the form of gestures and written key words to assist with comprehension. As described by Garrett and Lasker (2013), augmented input is the use of a visual or verbal strategy to increase the comprehension of people with aphasia. Augmented input commonly involves the inclusion of gesturing, writing keywords, or drawing presented simultaneously with verbal expression to support the comprehension.

The communication partner had 30 target line drawings plus 10 additional colored line drawings of nontarget words. Following the initial production by the participant, the
communication partner presented either a correct or incorrect image based on the response of the participant and whether it was an item predetermined to promote switching behavior. There were three possible responses by the communication partner to the communication attempts of the participant:

1. When the participant communicated the word *correctly*, and the item was predetermined to offer an image based on the participant’s response, the communication partner presented the *correct* image to the participant. Then, the researcher presented the next item to the participant.

2. When the participant communicated the word *incorrectly*, and the item was predetermined to be responded to based on the participant’s response, the *incorrect* image was presented to the participant. This was considered an opportunity for the participant to switch modalities.

3. When the participant communicated the word *correctly*, and the item was predetermined to promote switching behavior, an *incorrect* image was presented to the participant. When the incorrect image was presented to the participant, it was considered an opportunity to switch modalities. The communication partner did not indicate that a wrong choice had been provided.

Four measures were derived from the participant’s performance during the RCT: (1) A communicative flexibility score, (2) Accuracy of initial modality production, (3) Accuracy of second modality production, and (4) Combined modality usage. The communicative flexibility score was calculated by dividing the number of opportunities to switch by the number of successful modality switches. The second score, an accuracy
of initial modality production score, was calculated by dividing the number of targets by the number of accurate initial productions using any modality. The third score, an accuracy of second modality production score, was calculated by dividing the number of second modality attempts by the number of accurate second modality productions. In addition to the three scores, the mode of response was recorded for each target. If two modalities were produced at once, both modalities were recorded within the communication attempt (i.e., gesture and verbal). If at least one communication modality was correct (i.e., gesture), the communication attempt was scored as successful. A combined modality response was the fourth form of data obtained which was observed and documented throughout Baseline probes. Because the production of combined modalities was unexpectedly observed during the study, the researcher retrospectively began tracking this behavior.

Modality selection for treatment was determined by observation of the participant’s three most commonly used modalities during baseline probes. Possible modalities included writing, drawing, gesturing, pointing to a communication board, and verbalizing. The researcher intended to provide instruction in three modalities to reduce the cognitive demand of the participant to learn multiple modalities and optimize the use of familiar modalities. However, the participant used only two modalities throughout baseline probes (pointing to a communication board and verbalizing). Therefore, the researcher asked the participant and caregiver to select a third modality (gesturing) that was targeted during Treatment Phase 1.

**Treatment Sessions.** Each session began with a RCT probe for switching behavior as described above. Then, the researcher provided S+MCP intervention for 10 words from
one treatment word list during each of the two phases. S+MCP followed a two-step process, with each targeted word treated separately. The participant completed semantic treatment followed by multimodal treatment for one treated word prior to proceeding to the subsequent word.

**Semantic Treatment.** Following the completion of the RCT probe, the participant began semantic treatment. The researcher presented the participant with a colored line drawing of the target word stimulus paired with text representation of the target word typed in 36 Arial font on a 4X6 inch index card. The participant sorted the target word stimulus three times, once for each of three types of semantic features: category, location, and physical property. For each feature sort, the participant was presented with three index cards each containing a written semantic feature. One semantic feature was related to the target word stimulus and two were unrelated foils (Figure 6). The researcher read each feature answer choice and requested that the participant select the correct answer choice and placed the answer choice with the target drawing. When requested by the participant or if the participant did not understand the options presented, one repetition of the features was provided. The position of the correct answer was randomized. When the participant sorted the word incorrectly, the researcher modeled sorting the item correctly and the participant imitated correct placement of the item. After sorting the target word with each of three semantic features, the researcher proceeded to the multimodal communication program.
Figure 6. Example of a semantic feature category sort presented during semantic treatment.

**Multimodal Communication Program.** The participant received instruction related to three modalities for each of the ten treated words. Treatment Phase 1 targeted verbalizing, gesturing, and pointing to a communication board, while Treatment Phase 2 targeted the modalities of verbalizing, gesturing and drawing. The multimodal communication program (MCP) began with presentation of a colored line drawing depicting one of the 10 treated words. The researcher instructed the participant on the desired behavior to depict the pictured concept. The presentation order of each modality during instruction was randomized to control for order effect and participant learning as a potential threat to validity. The participant imitated each behavior and the researcher provided verbal feedback of correct versus incorrect productions. The researcher modeled the desired behavior one additional time if the participant had difficulty producing each modality accurately.
Following imitation on the use of the three modalities, the participant was instructed to produce the three modalities with minimal clinician cueing given the prompt, “Can you tell me all the ways to say this?” If the participant was unable to produce all three modalities, the clinician instructed the participant to produce the specific modality (i.e. “Gesture it”). Finally, the participant was instructed to produce the modalities again in a communicative context with the researcher. The researcher presented the participant with the target picture and asked “If I didn’t know what this was, how could you tell me this?” providing augmented input in the form of gestures to assist with comprehension. Then, the researcher asked “If I didn’t understand, how could you help me?” If the participant did not use all modalities, the researcher asked “How else can you tell me?” to elicit the modality. The researcher provided verbal feedback of correct versus incorrect productions and the researcher modeled the appropriate behavior if the participant had difficulty producing the modality accurately. If the modality was not used within ten seconds following this request, the participant was asked to use the modality specifically (e.g. “gesture it”).

The researcher provided augmented input and cueing throughout treatment to support the participant’s comprehension of treatment tasks. During Treatment Phase 1, the researcher used gestures to provide augmented input to assist with the participant’s comprehension. During Treatment Phase 2, in addition to gestures, the researcher provided the participant additional augmented input through presentation of written keyword cards (“Misunderstand” and “Help”) to assist with the participant’s comprehension of instructions. After completion of the multimodality intervention for a
single word, another word was introduced and the process was repeated beginning with the semantic treatment.

**Treatment Phase I.** The participant completed six sessions during Treatment Phase 1. The researcher provided intervention for 10 words (Treatment list 1). The three modalities targeted during multimodal intervention were gesturing, pointing to a communication board, and verbalizing, as determined by the Baseline performance. However, as the sessions progressed, the researcher observed that the participant used the communication board as a picture-matching task during treatment and RCT probes, rather than a communicative modality. Additionally, it was noted that the participant had difficulty completing the RCT probe as a communicative task, which was thought to be partially due to comprehension of task directions. Specific behaviors included pointing to both the target photograph provided by the researcher and the colored line drawing on the communication board to indicate a “match”. Furthermore, the participant routinely looked at the researcher following the communication attempt, rather than the communication partner, suggesting that his selection on the communication board was made without communicative intent.

**Treatment Phase II.** During the second treatment phase, the participant completed six sessions of intervention focused on the 10 words within Treated list 2. Due to the participant’s use of the communication board as a picture-matching task rather than for communication during Treatment Phase 1, the researcher discontinued intervention sessions with the communication board and introduced drawing during Treatment Phase 2. Thus this second treatment phase included the following three modalities: verbalizing, gesturing, and drawing. Drawing was selected to replace pointing...
to a communication board due to the participant’s artistic ability. The participant and his spouse indicated that although he had not been drawing frequently since his stroke, he was very artistic prior to his stroke and would likely succeed with drawing. Additional augmented input, including use of written key words and additional gestures were provided during Treatment Phase 2 to assist with comprehension. The participant was provided with the written words “Misunderstand” and “Help” consistently during treatment and the RCT probe as augmented input and carryover of instructions from treatment to the probe.

**Post-Intervention Sessions.** Post-Intervention sessions began 2 days following the completion of Treatment Phase 2, and ended 17 days following the completion of treatment. During these three sessions, the participant was re-assessed using the CADL-2 with modified scoring, the PPT, the WMS-III Spatial Span subtest, the Raven’s Colored Progressive Matrices and the RCT probe as described above. The participant completed the RCT probe during each of the three post-intervention sessions, while other assessments were each administered once.

**Data Analysis**

All study sessions were digitally video-recorded and all verbal and nonverbal responses on the RCT probe and CADL-2 modified scoring were transcribed. Dependent variables were measured using the participant’s performance on the RCT and the CADL-2 with modified scoring. The researcher computed effect sizes and completed visual analysis using the communicative flexibility score obtained from the RCT probe. Effect sizes were also computed for the accuracy of initial and second modality production
scores, as well as the combined modality use. The researcher analyzed the communicative flexibility score, accuracy of initial modality production and accuracy of second modality production during administration of the *CADL*-2 to determine effect size. Analyses of performance scores from each task are described in detail below. In addition to performance scores, the researcher computed interrater reliability for the RCT and *CADL*-2 modified scoring for 50% of each sample. Finally, standardized assessments completed during both Baseline and Post-Treatment were analyzed and an analysis of modality usage was completed. An independent observer determined treatment fidelity of S+MCP intervention sessions.

**RCT Analysis.** The participant’s performance on this task provided four types of data: (1) Communicative flexibility score, (2) Accuracy of initial modality production, (3) Accuracy of second modality production and (4) Combined modality usage. A switch was defined as an attempt to use a singular modality followed by an attempt to use another modality, or the addition of a modality whether correct or incorrect.

**Communicative Flexibility Score.** The communicative flexibility score was analyzed to answer research question 1 as to whether implementation of S+MCP affected the ability of an individual with aphasia and coexisting semantic deficits to switch among modalities when an initial communication attempt failed. The communicative flexibility score is computed by dividing the number of modality switches by the number of opportunities to switch.

**Percent of Non-Overlap.** The percent of non-overlapping data (PND) was determined by calculating the percent of data points within a phase which exceed the
single highest point of the previous phase (Parker & Vannest, 2009). PND was calculated for each word list separately (Treated list 1, Treated list 2, and Untreated list) for each phase of the study (Baseline, Treatment Phase 1, Treatment Phase 2, and Post-Treatment). For example, PND for Treated list 1 between Baseline and Treatment Phase 1 was determined by calculating the number of data points in Treatment Phase 1 that exceeded the highest data point of Baseline out of the total number of points in Treatment Phase 1. Results were analyzed to determine the effect of treatment on switching behavior between phases.

Non-Overlap of All Pairs. The non-overlap of all pairs (NAP) summarized the overlap of each data point within a phase compared to the subsequent phase. NAP is the percentage of comparison pairs with no overlap divided by the total number of comparisons (Parker & Vannest, 2009). For example, NAP for Treated list 1 between Baseline and Treatment Phase 1 was determined by comparing each data point of Baseline (6 total) to each data point within Treatment Phase 1 (6 total). The number of total data points within Treatment Phase 1 greater than the data points in Baseline (6 total) was divided by the total number of combination of pairs (36 total) to determine NAP. This percentage was analyzed to provide an additional measure of the effect of treatment on switching behavior between phases.

Visual Analysis. A visual analysis as described by Kratochwill et al. (2010) included an examination of predictable Baseline pattern, level, trend, variability, immediacy of effect, degree of overlap and consistency across phases was used to determine whether a relationship exists between S+MCP and switching behavior during
the RCT and the magnitude of the relationship. The visual analysis was completed for each word list separately.

A predictable Baseline pattern was determined by the researcher and two speech-language pathologists familiar with multimodal interventions. The Baseline pattern for switching behavior was determined to be stable across six Baseline probes prior to initiating Treatment Phase 1. The level is the visualization of the mean of all data points within a phase (Baseline, Treatment Phase 1, Treatment Phase 2, Post-Treatment). Trend was measured as the line of best fit of the data points for each phase of each word list. The researcher reported variability as the range within one standard deviation above and below the trend line for each phase. A series of ovals, squares, and triangles were used to visualize the immediacy of effect between phases. The last three data points of one phase and the first three data points of the subsequent phase were compared to determine if treatment had an immediate effect on switching behavior. The degree of overlap was visualized as the number of data points within a phase that overlapped with the highest data point of the previous phase. The consistency across Baseline and Post-Treatment phases was compared visually to determine if the trend of data points within Baseline differed from those within Post-Treatment for each word list.

**Accuracy of Initial and Second Modality Production.** The researcher calculated the accuracy of initial modality production by dividing the number of accurate initial modality productions by the total number of initial attempts during the RCT. The accuracy of second modality production was determined by dividing the number of accurate second modality productions by the total number of second modality attempts.
These scores were depicted on a graph to visualize the accuracy of modality production throughout the study.

**Combined Modality Production.** The researcher analyzed the participant’s use of combined modalities during RCT probes. Baseline and post treatment scores were examined for differences and the effect size was evaluated as described by Beeson and Robey (2006). First, scores from Baseline were averaged to represent \( A_1 \) and then calculated to determine the standard deviation \( S_1 \). Then, the score obtained from the Post-Treatment measure was indicated as \( A_2 \). The following formula was used to calculate effect size:

\[
Effect Size = \frac{A_2 - A_1}{S_1}
\]

**Interrater Reliability.** Interrater reliability was completed for 5 out of 20 RCT probes (25% of the sample) by a graduate speech-language pathology student familiar with cognitive flexibility and switching behavior measures. The student was blind to whether the words were treated or untreated. The student used a blank scoring sheet identical to that used by the researcher and was instructed on the target behaviors and scoring procedure. Initially, scoring for the sample was completed separately by the researcher and the graduate speech-language pathology student. Agreement between the researcher and the graduate speech-language pathology student for the attempted communication modality (singular and combined) was 93.10%. Agreement for the accuracy of initial production score was 95%, agreement for the switching score was 91%, and agreement of the accuracy of second modality score was 100%. Any discrepancies were resolved through discussion prior to final analysis.
**CADL-2 Modified Scoring Analysis.** The *CADL-2*, completed three times across Baseline sessions and one time within post-intervention sessions, was video recorded and all verbal and nonverbal responses were transcribed. Performance of this task provided three scores: (1) A communicative flexibility score, (2) Accuracy of initial modality production, and (3) Accuracy of second modality production.

The communicative flexibility score was analyzed to answer research question 2 as to whether implementation of S+MCP affected the switching behavior of an individual with severe aphasia and coexisting semantic deficits during administration of the *CADL-2*. Baseline and post treatment scores were examined for differences and the effect size was evaluated as described by Beeson and Robey (2006). First, scores from Baseline were averaged to represent \( A_1 \) and then calculated to determine the standard deviation \( S_1 \). Then, the score obtained from the Post-Treatment measure was indicated as \( A_2 \). The following formula was used to calculate effect size:

\[
Effect \ Size = \frac{A_2 - A_1}{S_1}
\]

**Interrater Reliability.** Scoring for the communicative flexibility score, the accuracy of initial modality production and accuracy of second modality production for the *CADL-2* was completed separately by the researcher and the graduate speech-language pathology student familiar with cognitive flexibility and switching behavior measures. Interrater agreement for modified scoring was completed for 2 out of 4 administrations of the CADL-2 (50% of the sample). Agreement for the accuracy of initial production score was 85%, agreement for the switching score was 90%, and agreement of the accuracy of second modality production was 100%. 
**Standardized Assessment Analysis.** The performance of the participant on selected formal assessments was evaluated during Baseline and post-intervention sessions to evaluate change in participant performance following intervention. These assessments included the *PPT*, the *CLQT Clock Drawing* and *Symbol Trails* subtests, the *Raven’s Colored Progressive Matrices*, and the *WMS-III Spatial Span* subtest. To account for possible minimal variation between scores obtained from Baseline and post-assessment measures, confidence intervals as determined by each test developer were used if necessary.

**Modality Analysis.** The researcher observed that the participant was very successful at producing the modalities during intervention but did not use the same modalities during the RCT task consistently. To better capture this observation, the researcher developed a post-intervention task to describe the participant’s production of multiple modalities independent of the RCT. During Post-Treatment sessions, the researcher assessed the participant’s ability to produce the trained modalities (verbalizing, gesturing, pointing to a communication board and drawing) using a two-part task. First, the researcher presented each target word image to the participant and requested that the participant “Show me all the ways you can say this” with no additional cueing provided. Marker, paper and a communication board were available to the participant for the task. The number and type of modalities produced were recorded, and the task was completed with all 30 words included in the study. For the second portion of the task, the researcher asked the participant to produce each modality (“Can you gesture this?”) given a photograph of the target word. The participant was asked to produce each modality (drawing, verbalizing, gesturing, and pointing communication board)
separately. The number and type of modalities produced were recorded and the task was completed for all 30 words included in the study. The participant’s accuracy in producing modalities for these two parts is presented in the Results section.

**Treatment Fidelity.** Treatment fidelity during intervention was determined by a speech-language pathology graduate student. This was completed for 3 out of 12 intervention sessions (25% of the sample). The graduate student used a list of guidelines that the researcher followed during each intervention session (e.g., providing a randomized presentation of target words across intervention sessions during S+MCP). The graduate student determined that the researcher followed 100% of the guidelines set forth for treatment.
CHAPTER III
RESULTS

This study examined the effects of S+MCP on the participant’s ability to switch modalities when an initial communication attempt failed during referential communication task (RCT) probes and administration of the CADL-2. First, analysis of the participant’s performance during the referential communication task (RCT) is described, including the switching behavior, accuracy of initial modality, accuracy of second modality, and combined modality production. Second, the participant’s response during the administration of the CADL-2 modified scoring are reported, including the participant’s switching behavior, accuracy of initial production, and accuracy of second production. Third, quantitative results of standardized testing are reported. Finally, an analysis of the participant’s ability to use the taught communication modalities is presented.

Results of Dependent Variables

Research Question 1. The purpose of research question 1 was to examine the effect of S+MCP on the ability of an individual with severe aphasia and coexisting semantic deficits to switch among modalities when an initial communication attempt failed during the RCT. In addition to the communicative flexibility score (i.e., measure of switching behavior), the accuracy of the initial and second productions as well as the number of combined modality productions were recorded.

Communicative Flexibility Score. The researcher computed the participant’s communicative flexibility score for all RCT probes. The participant’s communicative
Communicative flexibility scores for each word list across all RCT probes are available in Figure 8. The participant exhibited more switching behaviors during Post-Treatment RCT probes than in Baseline overall. The researcher further examined these results and calculated the percent of non-overlapping data (PND), the non-overlap of all pairs (NAP) (Parker & Vannest, 2009), and completed a visual analysis of data.

![Graph](image)

*Figure 7. Participant’s RCT communicative flexibility scores on all word lists.*
Figure 8. Participant’s RCT communicative flexibility scores on each word list.

**Percent of Non-Overlap.** The researcher used the following guidelines for determining effect size as defined by Parker and Vannest (2009): 0-50% indicates unreliable or weak effectiveness, 50-70% indicates questionable effect, and 71-90% indicates a fair effect and above 90% indicated a high level of effectiveness. The PND was calculated for each word list separately (Treated list 1, Treated list 2, and Untreated list). For Treated list 1, the PND between Baseline and Treatment Phase 1 was 16% (weak effect). Between Treatment Phase 1 and Treatment Phase 2, the PND was 0%, and between Treatment Phase 2 and Post-Treatment, PND was 66% (questionable effect). Analysis of PND for Treated list 2 was 0% between Baseline and Treatment Phase 1, 20% (weak effect) between Treatment Phase 1 and Treatment Phase 2, and 100% (large effect) between Treatment Phase 2 and Post-Treatment. Analysis of PND for Untreated list revealed a PND of 0% between Baseline and Treatment Phase 1, 80% (fair effect) between Treatment Phase 1 and Treatment Phase 2, and 66% (questionable effect)
between Treatment Phase 2 and Post-Treatment. Results indicated that S+MCP had a minimal to large effect between Treatment Phase 2 and Post-Treatment only (Table 3).

Table 3. Treatment effect of S+MCP as analyzed by Percent of Non-Overlap for each word list across phases.

<table>
<thead>
<tr>
<th>Treatment Effect of S+MCP on Switching Behavior During RCT Across Phases: Percent of Non-Overlap</th>
<th>Baseline→Treatment Phase 1</th>
<th>Treatment Phase 1→Treatment Phase 2</th>
<th>Treatment Phase 2→Post-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated list 1</td>
<td>16% (Weak Effect)</td>
<td>0% (No Effect)</td>
<td>66% (Questionable Effect)</td>
</tr>
<tr>
<td>Treated list 2</td>
<td>0% (No Effect)</td>
<td>20% (Weak Effect)</td>
<td>100% (Large Effect)</td>
</tr>
<tr>
<td>Untreated list</td>
<td>0% (No Effect)</td>
<td>80% (Fair Effect)</td>
<td>66% (Questionable Effect)</td>
</tr>
</tbody>
</table>

Non-Overlap of All Pairs. Parker and Vannest (2009) outlined the following determinates of effect size for non-overlap of all pairs (NAP): 0-65% indicates a weak effect, 66-92% indicates a medium effect, and 93-100% indicates a large effect. NAP was computed for each word list. The NAP for Treated list 1 was 16% (weak effect) between Baseline and treated list 1, 0% between treated list 1 and treated list 2, and 66% (medium effect) between Treatment Phase 2 and Post-Treatment. The analysis of Treated list 2 revealed a NAP of 0% between Baseline and Treated list 1, 20% (weak effect) between Treatment Phase 1 and Treatment Phase 2, and 100% (large effect) between Treatment Phase 2 and Post-Treatment. The NAP for untreated list was 0% between Baseline and Treatment Phase 1, 40% (weak effect) between Treatment Phase 1 and Treatment Phase 2, and 93% (large effect) between Treatment Phase 2 and Post-Treatment. Results indicated that S+MCP had a medium to large effect on switching behavior between Treatment Phase 2 and Post-Treatment (Table 4).
Table 4. Treatment effect of S+MCP as analyzed by Non-Overlap of All Pairs for each word list across phases.

<table>
<thead>
<tr>
<th>Treated list 1</th>
<th>Baseline→Treatment Phase 1</th>
<th>Treatment Phase 1→Treatment Phase 2</th>
<th>Treatment Phase 2→Post-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated list 2</td>
<td>0% (No Effect)</td>
<td>20% (Weak Effect)</td>
<td>100% (Large Effect)</td>
</tr>
<tr>
<td>Untreated list</td>
<td>0% (No Effect)</td>
<td>40% (Weak Effect)</td>
<td>93% (Large Effect)</td>
</tr>
</tbody>
</table>

Visual Analysis. The visual analysis, including the predictable Baseline pattern, level, trend, variability, immediacy of effect, degree of overlap, and consistency across similar phases is described in the following sections.

Predictable Baseline pattern. The researcher determined Baseline switching behavior through measurement of the communicative flexibility score. The participant presented with a stable switching behavior occurrence of 0% during all six Baseline RCT tasks for all three word lists.

Level. For Treated list 1, the mean cognitive flexibility score was 0% at Baseline, 3% within Treatment Phase 1, 0% during Treatment Phase 2, and 25% during Post-intervention sessions. The mean cognitive flexibility score for Treated list 2 was 0% at Baseline, 0% within Treatment Phase 1, 2% during Treatment Phase 2, and 50% during Post-intervention sessions. The level of the communicative flexibility score for the
untreated list were 0% during Baseline, 0% during Treatment Phase 1, 7% within Treatment Phase 2, and 28% at Post-intervention (Figure 9).

Figure 9. Visual analysis of level for communicative flexibility score during the RCT.

Trend. A graph of the trend line for the RCT for each of the three word lists is available in Figure 10. The trend line at Baseline and Treatment Phase 1 for all three word lists remained stable. However, the trend lines of Treatment Phase 2 demonstrated a minimal progression toward increased switching behavior for the Untreated list and Treated list 1, while Treated list 2 remained stable. The Post-Treatment trend lines for all
three word lists are variable, indicating that the most change in switching behavior was visualized during Post-Treatment.

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Treatment Phase 1</th>
<th>Treatment Phase 2</th>
<th>Post-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated list 1</td>
<td>0%</td>
<td>0-11</td>
<td>0%</td>
</tr>
<tr>
<td>Treated list 2</td>
<td>0%</td>
<td>0-6</td>
<td>0-18</td>
</tr>
<tr>
<td>Untreated list</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

![Graph](image)

*Figure 10.* Visual analysis of trend for communicative flexibility score during the RCT.

**Variability.** The variability is reported as the range one standard deviation above and below the trend line. There was no range at Baseline for all three word lists because the participant’s switching behavior was 0%. During Treatment Phase 1, the variability was 0-11 for Treated list 1, with no variability for Treated list 2 and Untreated list. During Treatment Phase 2, the variability was 0 for Treated list 1, 0-6 for Treated list 2, and 0-18 for Untreated list. Within the Post-Treatment, the variability for Treated list 1
was 4-46, for Treated list 2 variability was 32-68, and 16-40 for Untreated list. The variability can be visualized in Figure 11.

![Graph showing variability for the communicative flexibility score of the RCT.](image)

*Figure 11. Visual analysis of variability for the communicative flexibility score of the RCT.*

*Immediacy of Effect.* To observe the immediacy of effect, the last three data points of one phase and the first three data points of the next phase were visually compared using shapes (i.e., ovals, rectangles and triangles). The observed effects are not immediate across Baseline, Treatment Phase 1, and Treatment Phase 2. A positive effect
was visualized between Treatment Phase 2 and Post-Treatment for Treated list 2 and Untreated list. For all three word lists, change was visualized during Post-Treatment (Figure 12).

*Figure 12.* Visual analysis of immediacy of effect for the RCT communicative flexibility score.

*Degree of Overlap.* The degree of overlap of data points between each adjacent phase was analyzed for each word list. Between Baseline and Treatment Phase 1, Treated list 1 had 5 overlapping data points (83%), and both Treated list 2 and Untreated list had 6 overlapping data points (100%). Between Treatment Phase 1 and Treatment Phase 2,
Treated list 1 had 6 overlapping data points (100%), Treated list 2 had 4 (80%), and Untreated list had 3 (60%). Between Treatment Phase 2 and Post-Treatment, Treated list 1 had 1 overlapping data point (33%), Treated list 1 had 0 (0%), and Untreated list had 1 (33%). These results indicate that the least amount of overlapping points occurred during Post-Treatment for all words lists, suggesting that increased switching behavior change was most evident during Post-Treatment (Figure 13).

*Figure 13.* Visual analysis of degree of overlap for communicative flexibility during a RCT.
Consistency Across Phases. The data patterns of similar phases indicated a consistent pattern of switching behavior between both treatment phases. However, between Baseline and Post-Treatment, switching behavior was not consistent, demonstrating a change in performance following S+MCP. This is demonstrated in Figure 14 in the linked ovals.

Figure 14. Visual analysis of consistency across phases for RCT communicative flexibility.

Accuracy of Initial Modality Score. The researcher calculated the accuracy of initial modality production score by dividing the number of accurate initial modalities
productions by the total number of initial attempts during the RCT. Results revealed that the participant’s initial productions were 100% accurate during Baseline and Treatment Phase 1 due to the participant’s success in using the communication board accurately. The communication board was removed during RCT probes 15-20 to examine the participant’s switching behavior for the modalities taught during Treatment Phase 2. Subsequently, a decrease in the participant’s accuracy of initial productions was revealed. The participant’s accuracy of initial production score (percentage) during the RCT task probes is displayed in Figure 15.

![Figure 15](image)

*Figure 15. Accuracy of initial modality production across sessions.*

*Accuracy of Second Modality Production.* The researcher calculated the accuracy of second modality production score by dividing the number of accurate second modality production by the total number of second modality attempts during the RCT. The participant’s second productions were 100% accurate during Baseline and Treatment
Phase 1 during which time he used the communication board exclusively. Often, the second modality produced was the same as the modality produced during the initial attempt. That is, the participant did not often produce a different modality on the second attempt, which is reflected in his switching score. However, when the communication board was removed during RCT probes 15-20 to examine the participant’s switching behavior for the modalities taught during Treatment Phase 2, a decrease in the participant’s accuracy occurred. The accuracy of second modality production (percentage) during the RCT task probes is displayed in Figure 16.

![Figure 16](image)

*Figure 16. The accuracy of second modality production during RCT task.*

**Combined Modality Production.** The researcher analyzed the effect of S+MCP on the participant’s use of combined modalities during RCT probes. Results indicated that the participant produced more combined modalities during Post-Treatment than
during Baseline RCT probes. S+MCP treatment was found to have a small statistically significant effect size (d=7.36) for Treated list 1, a medium statistically significant effect size for Treatment list 2 (d=16.16), and a large effect size for Untreated list (d=37.14). The participant’s use of combined modalities across all three word lists is presented in Figure 17, while the participant’s use of combined modalities during the RCT task probes separated by word list is available in Figure 18.

![Figure 17. Participant’s use of combined modalities during RCT probes (combined).](image)
Research Question 2. Analysis of research question 2 examined whether implementation of S+MCP affected the ability of an individual with severe aphasia and coexisting semantic deficits to switch among modalities when an initial communication attempt failed during administration of the CADL-2. The researcher used modified scoring to determine the communicative flexibility score and also recorded data related to the accuracy of the initial and second productions.

*Communicative Flexibility Score.* The communicative flexibility score was determined by the number of switches divided by the number of opportunities to switch. Following treatment, the participant demonstrated an increase in switching behavior compared to Baseline. The treatment was found to have a small statistically significant
effect size (d=6.58). The participant’s communicative flexibility scores (percentage) during administration of the CADL-2 with modified scoring are displayed in Figure 19.

Figure 19. Communicative flexibility scores during administration of the CADL-2 with modified scoring.

Accuracy of Initial and Second Modality Production Score. The researcher documented the accuracy of the participant’s initial modality production and second modality production during administration of the CADL-2 with modified scoring. Analysis of the accuracy of initial production score revealed nearly the same accuracy of initial production score between Baseline and Post-Treatment. During Baseline, the participant averaged 20% accuracy with initial modality production and achieved 19% accuracy at Post-Treatment. The treatment was found to have no effect on accuracy of initial modality production during administration of the CADL-2 (d=0.26). Analysis of the accuracy of second modality production revealed an increase in the accuracy of second production score between Baseline and Post-Treatment. The participant averaged
16% accuracy with second modality production at Baseline and 33% accuracy at Post-Treatment. However, this increase was not determined to be statistically significant with no treatment effect (d=.997). As with the RCT probe, the second modality was typically the same as the initial modality, which is reflected in his switching score.

**Results of Standardized Testing**

The participant’s standardized testing scores Post-Treatment are reported in Table 5. The participant’s raw score during CADL-2 with standard scoring decreased between Baseline and Post-Treatment. Currently, there is no available data on the expected variability of multiple administrations of the CADL-2 for people with aphasia. Rather than this decrease reflecting a clinically meaningful difference, it may illustrate the session to session variability that might be expected in a person with aphasia (McNeil & Pratt, 1992). As predicted, the participant’s score on the WMS-III Spatial Span Subtest did not change following treatment as this treatment was designed to improve switching behavior, not working memory. The participant’s raw score on the Raven’s Coloured Progressive Matrices decreased during Post-Treatment by 2 points. This difference may also be explained by the variability people with aphasia’s performance on cognitive tasks (McNeil & Pratt, 1992). Furthermore, the participant’s scores during the administration of the PALPA Subtests 48 and 51 decreased by two points and remained the same, respectively. Little to no change in these scores as a result of this treatment were likely due to the nature of the subtests, which required the participant to independently read written words, differing from the presentation of stimuli during experimental tasks. A change in this score was not expected due to the participant’s underlying auditory comprehension impairment that affected his ability to understand spoken language. The
The participant’s raw score on **PALPA** Subtest 47 increased by 3 points and as with other minimal changes during Post-Treatment assessments, this change may be explained by the variability of the performance of people with aphasia (McNeil & Pratt, 1992). The participant’s raw score on the **PPT** increased 16 points following treatment. While there is limited psychometric data available for this test, test developers reported that a raw score of 26 out of a possible 52 is expected by chance while a score of 38 or higher out of a possible 52 is better than chance. The participant’s raw score at Baseline was similar to chance at 53.85% correct (28/52), while his score Post-Treatment was better than chance at 84.61% correct (44/52).

<table>
<thead>
<tr>
<th>Test</th>
<th>Baseline</th>
<th>Post-Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Communicative Activities of Daily Living-2</strong></td>
<td>35/100</td>
<td>30/100</td>
</tr>
<tr>
<td><strong>Pyramids and Palm Trees Test</strong></td>
<td>28/52</td>
<td>44/52</td>
</tr>
<tr>
<td><strong>Wechsler Memory Scale-III: Spatial Span Subtest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forward</td>
<td>4/16</td>
<td>4/16</td>
</tr>
<tr>
<td>Backward</td>
<td>4/16</td>
<td>3/16</td>
</tr>
<tr>
<td><strong>Psycholinguistic Assessment of Language Processing in Aphasia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtest 47: Spoken Word Picture Matching</td>
<td>19/40</td>
<td>22/40</td>
</tr>
<tr>
<td>Subtest 48: Written Word Picture Matching</td>
<td>16/40</td>
<td>14/40</td>
</tr>
<tr>
<td><strong>Raven’s Coloured Progressive Matrices</strong></td>
<td>29/37</td>
<td>27/37</td>
</tr>
</tbody>
</table>

*Table 5. Post-Treatment standardized assessment scores.*

**Modality Analysis**

The modality analysis included the participant’s Post-Treatment productions of each modality for all words under two conditions: spontaneous and elicited. The participant’s accurate productions out of the number of attempts to produce each modality can be found in Table 6. Generally, his attempts and accuracy varied across
modalities and across sessions. Overall, the participant produced more responses and attempted more communication modalities within the elicited rather than spontaneous condition. For example, during Post-Treatment session 1 and Post-Treatment session 3, he did not attempt to gesture spontaneously, but during Post-Treatment session 2, he attempted to gesture and was successful for eight out of fifteen attempts. In contrast, he attempted gestural responses during all Post-Treatment session within the elicited condition.

<table>
<thead>
<tr>
<th>Spontaneous Modality Assessment (Successes/Attempts)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-Treatment 1</strong></td>
</tr>
<tr>
<td>Verbal</td>
</tr>
<tr>
<td>Gestural</td>
</tr>
<tr>
<td>Communication Board</td>
</tr>
<tr>
<td>Drawing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elicited Modality Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-Treatment 1</strong></td>
</tr>
<tr>
<td>Verbal</td>
</tr>
<tr>
<td>Gestural</td>
</tr>
<tr>
<td>Communication Board</td>
</tr>
<tr>
<td>Drawing</td>
</tr>
</tbody>
</table>

Table 6. Post-Treatment Modality Production Successes/Attempts.
CHAPTER IV

DISCUSSION

This study investigated the effects of S+MCP on switching behavior during an RCT probe and the CADL-2 for a person with severe aphasia and coexisting semantic deficits. As hypothesized, S+MCP resulted in an increase in the participant’s number of successful switches to alternative modalities when an initial communication attempt failed on both the RCT probe and the CADL-2. The improvement in switching behavior on two types of communicative scenarios may provide support for the use of S+MCP to improve overall communicative effectiveness, as switching behavior may be improved on multiple tasks. These results provide preliminary support for the efficacy of S+MCP as an effective method for improving switching behavior in people with severe aphasia and coexisting semantic deficits.

Improvement in switching behavior following S+MCP was expected because the treatment aimed to address potential deficits related to both steps of Dell’s model of lexical retrieval (Dell et al., 2004). The semantic treatment appeared to improve step 1 in lexical access, lemma access, thus improving the participant’s ability to retrieve the concept of the item presented. Through integrated instruction in multiple modalities, MCP aimed to instruct the use in alternative modalities in order to circumvent deficits in step 2 of lexical access, phonological access, and communicate a concept using an alternative modality when verbal output failed. This treatment was provided in an integrated manner to simultaneously address semantic deficits and multiple modalities to improve switching behavior. S+MCP holds promise as a treatment technique that can improve communicative effectiveness of some people with aphasia.
In addition to the anticipated results, the researcher identified various notable findings related to the participant’s responses during RCT probes. Patterns of performance were easier to detect during RCT probes than the CADL-2 because RCT probes occurred throughout treatment. First, the S+MCP treatment effect was demonstrated for untreated words. Second, the treatment effect resulting from S+MCP on the RCT probe was delayed. Third, treatment resulted in an increased use of combined modalities (e.g., verbal plus gesture). The following sections will describe these findings and provide a review of their clinical and future research implications.

**Effect on Untreated Words**

Based on a previous study (Purdy & VanDyke, 2011) as well as Dell’s model of semantic activation (Dell et. al., 2004), S+MCP sought to strengthen semantic networks and teach alternative communication modalities in an integrated manner, thus improving semantic access to concepts and switch to alternative communication modalities when a communication attempt failed. As a result of treatment, switching behavior was shown to improve for all word lists, including the untreated list. Generalization to the untreated word list may have resulted from S+MCP providing strategy instruction for the participant rather than only increasing automaticity for treated words. That is, after multiple opportunities to practice using multiple modalities in an integrated manner, the participant generalized this strategy as a method to resolve communication breakdowns. Researchers have suggested that other word retrieval treatments that are typically thought to improve an underlying linguistic process may be used as a strategy to improve word retrieval during communication breakdowns (Wambugh, et al., 2013). However, this
possibility, both for semantic treatments and multimodal interventions warrants further investigation.

Delayed Treatment Effect

The participant exhibited an increase in switching behavior on the RCT probe following S+MCP. However, the greatest treatment effect size was found to be between Treatment Phase 2 and Post-Treatment sessions (i.e., after 12 treatment sessions). A change in switching behavior was not detected until the RCT probe of treatment session 11. These results indicate that the participant required a greater number of treatment sessions than expected to learn the behavior. It was hypothesized that the participant would begin to learn switching behavior within six treatment sessions (i.e., the end of Treatment Phase I) based on results from one participant in a previous study (Purdy & VanDyke, 2011). Despite the inclusion of the semantic intervention in the current study, results were similar to response of a participant with an equally significant semantic impairment, in that both participants required more than eight sessions of MCP treatment. Although many possible explanations for these results exist, the following three will be explored here: (1) Poor comprehension of RCT task instructions, (2) Need for an initial isolated semantic intervention or modifications to semantic treatment, and (3) Influence of cognitive impairments.

The participant’s WAB-R Auditory Verbal Comprehension score of 3.5/10 indicated a significant impairment in auditory comprehension. In people with aphasia, decreased comprehension is likely due to decreased access to the available processing resources (McNeil & Pratt, 2001). However, redundancy of information has been shown to decrease the processing load and thereby increase comprehension (Wright & Newhoff,
2004). As such, the researcher provided augmented input including writing keywords and gesturing to support the participant’s comprehension of intervention instructions (Garrett & Lasker, 2013). Augmented input provides redundancy of the information presented with the goal of reducing the processing load of the person with aphasia. During Treatment Phase 1, the researcher provided gestural augmented input, but added written key words with additional gestural input for Treatment Phase 2 because the participant appeared to misunderstand instructions during the RCT probe and treatment sessions. This was noted when the participant required multiple reiterations of instructions to imitate productions of targeted communication modalities during treatment sessions (i.e. imitating the gestural production of the target). These observations are consistent with Chiou and Kennedy (2009), in which comprehension deficits impacted the participants’ ability to understand task instructions, limiting their performance on a Go/No-Go task. This increase in augmented input appeared to be helpful in this study to increase engagement and participation in both treatment sessions and the RCT probe. As such, augmented input should continue to be used during aphasia treatments to increase auditory comprehension of individuals with aphasia.

A second possible explanation for the delayed treatment effect may relate to the timing of the semantic intervention during MCP treatment. Due to the severity of the participant’s semantic impairment, it might have been beneficial for the participant to complete some initial semantic intervention sessions in isolation prior to initiating S+MCP. Purdy and VanDyke (2011) found that the participant with an impaired semantic system did not improve switching behavior following MCP alone as much as the participant without a semantic impairment. Therefore, if the participant were provided a
brief course of additional semantic treatment tasks prior to initiation of S+MCP, he may have responded to S+MCP because of improvements within his semantic system, possibly increasing his access to the lemma of a concept prior to treatment.

Additionally, an earlier semantic treatment could be modified to enhance the semantic system beyond what was achieved with a nonverbal semantic feature sorting task. Drew and Thompson (1999) suggested that semantic treatments that include categorical tasks, yes/no question responses, either/or questions, and matching a spoken definition to a picture may improve lemma and phonological access for people with severe aphasia. The addition of these tasks, the researcher concludes, may improve semantic skills beyond the effect of this study. Because S+MCP is rooted in Dell’s model of semantic activation (Dell et. al., 2004), enhancing semantic networks may assist with connection of an alternate modality to its referent.

A third explanation for the delay in treatment response relates to the potential impact of cognitive impairments. The participant’s nonverbal cognitive status was impaired as determined by a raw score on the CLQT Symbol Trails Subtest of 0/10, CLQT Clock Drawing Subtest raw score of 1/13 and WMS-III Spatial Span Subtest raw score of 4/16. The participant’s switching behavior on the RCT improved, but switching did not occur during each communication breakdown. The participant’s cognitive impairments may have affected his awareness of communication breakdowns as an important step to initiate switching to an alternate modality. This is illustrated through consideration of switching as a three step process: (1) Recognizing a failed communication attempt, (2) Retrieving representation for the production of the symbol in an alternate modality, and (3) Switching to use of an alternative modality (Purdy, Duffy,
& Coelho, 1994). Although S+MCP was designed to improve switching behavior, it did not specifically address Step 1, which requires awareness of errors. This awareness may be an important step to switching to an alternate communication modality successfully.

Additionally, cognitive impairments such as deficits in cognitive flexibility may have continued to affect switching behavior as evident by the participant’s performance on the modality analysis task. The participant was able to produce most items using each modality, except for verbalizing, during the modality analysis completed Post-Treatment. This suggests that he may have been better able to produce the modality than to switch between modalities.

While the effect of cognitive impairments should be examined further, one potential method for increasing awareness of failed communication attempts would be to add awareness training to S+MCP. The purpose of adding this type of training would be to provide explicit instruction related to recognition of a communication breakdown in a manner that could be understood by people with comprehension and cognitive impairment. One approach would be to use an implicit learning task in which the researcher provides feedback related to correct or incorrect responses. While no known studies have examined this use of awareness training in people with aphasia, previous studies support the use of this type of instruction for people following right and left hemisphere strokes (McEwen et. al, 2010; Skidmore et. al, 2011). This topic would require investigation to determine if awareness training might increase the benefit people with aphasia would derive from S+MCP.

**Combined Communication Modalities**
Another unexpected treatment outcome was the increase in the participant’s combined communication attempts. The most significant increase was noted with verbal plus gesture communication attempts. That is, following S+MCP, the participant increased his use of gestures during verbalizations, despite his inability to accurately verbalize the target words. These results are consistent with reports that people without language impairments (McNeill, 1992) and people with aphasia (Wilkinson et al., 2010) often gesture when speaking. Additionally, studies support an increase in gesture production regardless of the ability to name items following a semantic plus gesture intervention (Rodriguez, Raymer & Rothi, 2006). Similarly, in the current study, gestures provided a reliable alternative means of communication and did not reduce attempts at verbal communication. This current study may provide further evidence to support the inclusion of gestures in treatments for aphasia.

**Limitations/Future Research**

Results of this study provide preliminary information regarding the possible outcomes of S+MCP with a person with severe aphasia and coexisting semantic deficits. The findings of this investigation are based on a single participant, therefore limiting the ability to extend the results to other people with aphasia. However, for the purpose of this initial research, the results obtained from this single-subject design were informative and important to develop considerations for future research. Because the data supported the study’s hypotheses, there now is evidence to suggest that conducting further studies with more people with aphasia is warranted.

In addition to the sample size, another limitation of the study is related to the use of a structured task to measure switching behavior. As such, the participant’s use of the
communication board as a “picture-matching” instrument was observed due to the structured nature of the RCT probe. When shown a photograph during the RCT probe, the participant often pointed to the corresponding drawing on the communication board, pointed to the target photograph, and then looked at the researcher, minimally attending to the communication partner. The RCT probe was used as a structured task to measure the participant’s ability to communicate a single pictured concept to a communication partner. This task was appropriate for this early stage of research of S+MCP to investigate the use of switching behavior in structured contexts, as it is important to explicitly measure switching behavior. While unexpected “picture-matching” was observed, the structure of the task revealed preliminary information regarding the participant’s fundamental use of switching behavior and whether that behavior could be increased on a structured task following S+MCP. Because the participant demonstrated improvement in switching behavior on both the structured RCT probe and the CADL-2, future research of treatments to improve switching behavior may need to include real-life communicative scenarios to measure switching behavior in less-structured contexts.

Experts agree that people with aphasia benefit from explicit instruction in the communicative use of alternative modalities in real-life communicative scenarios (Garrett & Lasker, 2006; King, 2013). Also, extending successful use of communication strategies from structured tasks to authentic activities may encourage acceptance of alternate communication strategies (Weissling & Harvey, 2013). A possible future modification to S+MCP is to include a communicative task with a communication partner during treatment sessions to improve carryover from treatment to the RCT probe and eventually, real-life functional activities. As such, these real-life scenarios may better determine the
switching behavior of people with aphasia in communicative contexts. Future research may also incorporate a real-life scenario as a measure of switching behavior to determine if S+MCP can impact the behavior in natural communicative contexts.

Due to the notable findings of this study, future investigations of treatments to improve switching behavior may incorporate modifications to account for these findings. These modifications include providing increased augmented input from the beginning of treatment to increase the comprehension of all aspects of treatment, including RCT task instructions, and treatment instructions. Furthermore, initiating a semantic treatment prior to S+MCP may be beneficial to improve the semantic system, thus increasing the impact of a multi-modal treatment. The semantic treatment itself warrants further investigation to determine the most effective non-linguistic treatment for people with severe aphasia. Finally, the inclusion of awareness training may be used to increase mindfulness of communication breakdowns.

The purpose of a multimodal communication program is to enhance the ability of people with aphasia to learn to use and switch between alternative modalities when an initial communication attempt fails. Improvements in switching behavior are a critical element to increasing overall communicative effectiveness of people with severe aphasia. The participant in this study demonstrated a limited ability to communicate verbally due to his aphasia severity and coexisting semantic deficits. Treatments in alternative modalities and switching behavior may improve the overall communicative effectiveness of people with aphasia because of improvement in the ability to communicate a concept. Ideally, increased participation in daily communication is a goal of switching behavior.
improvement. Further investigation of multimodal treatment for switching behavior is warranted to determine the efficacy of this treatment and its use in a clinical setting.
References


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Appendix 1 Recruitment Flyer

Aphasia Research Study

Research participants needed:
Combined Semantic + Multimodal Therapy for People with Aphasia

The purpose of this research study is to evaluate a treatment designed to help people with aphasia learn to use alternative communication modes.

- Are you between 18 and 85 years of age?
- Is American English your primary language?
- Do you have a language problem resulting from a stroke or brain injury?
- Did your stroke or brain injury happen over 6 months ago?
- Are you not currently enrolled in individual speech therapy?

If you answered YES to these questions, you may be eligible to participate in this research study.

This study is being conducted at the Speech-Language-Hearing Clinic at Duquesne University. Volunteers will participate in evaluation and treatment sessions that may last up to 3 to 4 months (up to 19 sessions total). Each session will be 1-2 hours. Arrangements can be made to accommodate your schedule as needed.

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Appendix 2: Example Vision Screen

TOM  BOB  FRANK
  JOE  JIM  CRAIG
LEON  BOB  FRANK
TOM  BOB  JOE
CRAIG  EMILY  GREG
FRANK  BOB  JOE
JOHN  EMILY  FRANK
JOE  FRANK  TIM
  BOB  JIM  LEON