ABSTRACT

A FUNCTIONAL GESTURAL COMMUNICATION INTERVENTION FOR INDIVIDUALS WITH CHRONIC AND SEVERE APHASIA

by Skylar Kay Powlen

Introduction: Gestural communication intervention programs have been cited within the literature as a means to compensate for the deficits of aphasia. The purpose of this study was to determine whether an intensive, personally relevant (PR), gesturally based group intervention program, would support comprehension and gestural expression in individuals with severe chronic aphasia. Methods: Four participants were enrolled in a single case research design for nine, two-hour treatment sessions, over three weeks. Participants received gestural training of PR stimuli in an intensive, group intervention. Results: Three of the four participants demonstrated large effect sizes within gestural comprehension. All of the participants demonstrated positive gains in gestural production of category and PR words. Conclusions: Comprehension can be enhanced with the use of personally relevant gestures in an intensive group intervention. In addition, production of PR gestures can increase following an intensive treatment protocol; however, results were variable due to participant’s limb apraxia.
A FUNCTIONAL GESTURAL COMMUNICATION INTERVENTION FOR INDIVIDUALS WITH CHRONIC AND SEVERE APHASIA

A Thesis

Submitted to the
Faculty of Miami University
in partial fulfillment of
the requirements for the degree of
Master of Arts
Department of Speech Pathology and Audiology
by
Skylar Kay Powlen
Miami University
Oxford, Ohio
2015

Advisor_______________________________
Kelly Knollman-Porter Ph.D.

Reader_______________________________
Donna Scarborough Ph.D.

Reader_______________________________
Laura Kelly Ph.D
Table of Contents

Introduction ........................................................................................................................................... 1
Methods ................................................................................................................................................. 5
Results .................................................................................................................................................. 15
  Gestural Comprehension - Response to Treatment ................................................................. 15
  Category specific gestural comprehension - response to treatment ................................. 15
  Personally relevant stimuli gestural comprehension – response to treatment .......... 18
Gestural Expression- Response to Treatment ............................................................................ 22
  Category specific gestural expression - response to treatment ........................................... 22
  Personally relevant stimuli gestural expression – response to treatment .................... 25
Verbal Expression - Response to Treatment ............................................................................. 31
Discussion ......................................................................................................................................... 35
References ......................................................................................................................................... 40
Appendices ....................................................................................................................................... 46
  Appendix A ..................................................................................................................................... 46
List of Tables

Table 1. Participant demographic information and standardized assessment results .......................6

Table 2. Category specific data average percent correct responses during an gestural comprehension task across treatment, probe, and maintenance phases for all participants .................................................................17

Table 3. Category specific data average percent correct responses during an expressive gesture task across treatment, probe, and maintenance phases for all participants ..................24
List of Figures

Figure 1. Representation of treatment protocol............................................................. 10

Figure 2. Participant 1’s average percent correct responses during an auditory and gestural
comprehension task across baseline, treatment, and maintenance phases....................19

Figure 3: Participant 2’s average percent correct responses during an auditory and gestural
comprehension task across baseline, treatment, and maintenance phases. .................20

Figure 4: Participant 3’s average percent correct responses during an auditory and gestural
comprehension task across baseline, treatment, and maintenance phases....................21

Figure 5: Participant 4’s average percent correct responses during an auditory and gestural
comprehension task across baseline, treatment, and maintenance phases....................22

Figure 6: Participant 1’s average percent correct responses during an expressive gestural
communication task across baseline, treatment, and maintenance phases...................26

Figure 7: Participant 2’s average percent correct responses during an expressive gestural
communication task across baseline, treatment, and maintenance phases...................28

Figure 8: Participant 3’s average percent correct responses during an expressive gestural
communication task across baseline, treatment, and maintenance phases...................29

Figure 9: Participant 4’s average percent correct responses during an expressive gestural
communication task across baseline, treatment, and maintenance phases...................31

Figure 10: Participant 1’s average percent correct responses during a verbal expression task
across baseline, treatment, and maintenance phases.................................................32

Figure 11: Participant 2’s average percent correct responses during a verbal expression task
across baseline, treatment, and maintenance phases.................................................33

Figure 12: Participant 3’s average percent correct responses during a verbal expression task
across baseline, treatment, and maintenance phases.................................................34

Figure 13: Participant 4’s average percent correct responses during a verbal expression task
across baseline, treatment, and maintenance phases.................................................35
Introduction

Persons with severe aphasia can exhibit co-occurring expressive and receptive deficits, which can negatively affect their ability to verbally express and comprehend basic and essential wants, needs, or ideas well into the chronic stages of recovery (Aftonomos, Appelbaum, & Steele, 1999; Gialanella, 2011; Hanlon, Brown, & Gerstman, 1990; Knollman-Porter, Dietz, & Lundeen, 2015; McNeil & Pratt, 2001). Because these limitations can be long standing, severe aphasia can negatively affect individuals self-identity, the quality and quantity of social relationships, and vocational opportunities leading to a decreased quality of life (Brown, Worrall, Davidson, & Howe, 2012; Davidson, Howe, Worrall, Hickson, & Togher, 2008; Hilari & Northcott, 2006; Parr, 2007; Penn, & Jones, 2000; Shadden, 2005). In addition, while rehabilitation efforts are often implemented, individuals with severe verbal expression and comprehension deficits experience increased dropout and discontinuation rates for rehabilitation services when compared to those with milder impairments (Paolucci et al., 2005; Parr, 2007). Hence, rehabilitative and functional outcomes can also be negatively impacted (Paolucci et al., 2005). Further examination into methods of intervention, which restores or compensates for the long-standing, functional communication limitations of severe aphasia, is warranted.

Restorative aphasia treatment approaches focus on the reacquisition of lost abilities or the improvement of residual skills (Mollica, 1999). More specifically, greater improvements in communication outcomes have been noted if the restorative protocols are (a) intensive, (b) repetitive, (c) salient, and (d) are provided by a certified speech language pathologist (Denes, Perazzolo, Piani, & Piccione, 1996; Kleim & Jones, 2008; Meinzer, Djundja, Barthel, Elbert, & Rockstroh, 2005; Pulvermuller et al., 2001). The degree to which treatment intensity influences verbal expression and auditory comprehension outcomes has been of focus in recent aphasia literature (Kleim & Jones, 2008; Knollman-Porter et al., 2015; Meinzer et al., 2005; Pulvermuller et al., 2001; Robey, 1998). Treatment programs of this nature have ranged across three categories including; low (≤1.5 hours of treatment per week), moderate (2 to 3 hours of treatment per week), and high (≥5 hours of treatment per week) levels of intensity (Robey, 1998), and have been implemented for persons with moderate to severe aphasia within both the acute (Denes et al., 1996) and chronic phases of recovery (Knollman-Porter et al., 2015; Meinzer et al., 2005; Pulvermuller et al., 2001). Intensive interventions have resulted in greater gains in verbal expression, when compared to those who have had similar treatments in a less intensive manner.
In addition to verbal expression gains, positive outcomes in single word comprehension ability, following an intensive repeated auditory stimulation intervention for persons with chronic, severe aphasia have been noted (Knollman-Porter et al., 2015). Altogether, intensive intervention has been found to be one beneficial component of restorative intervention (Cherney et al., 2008; Robey, 1998).

An additional feature within restorative techniques is the utilization of salient interventions, or treatment protocols that consider the importance of a given experience, in order for it to become meaningful to an individual (Kleim & Jones, 2008). In particular, personally relevant (PR) stimuli, which incorporates personally relevant information, is an element of salience that has been used in research protocols (McKelvey, Hux, Dietz, & Beukelman, 2010). Presenting names of family members, familiar places, or commonly used objects are examples of PR stimuli, which are functional in terms of serving a purpose for activities of daily living (ADLs) (Knollman-Porter & Grant-Kinne, 2013). While salient, restorative treatments for severe, chronic expressive and receptive aphasia are limited, new protocols are emerging. More specifically, improvements in auditory comprehension, for persons with severe expressive and receptive deficits were observed during a moderately intensive, PR treatment program (Knollman-Porter & Grant-Kinne, 2013). However, even with these gains the authors recognized that participants continued to present with residual deficits that would negatively influence functional communication (Knollman-Porter & Grant-Kinne, 2013). While restorative interventions that are intensive and salient have led to positive clinical gains, residual and chronic comprehension and expressive deficits from aphasia often remain. As a result, alternative means of intervention have been considered to aid in compensating for the chronic, severe expressive and receptive deficits of aphasia.

Persons with severe aphasia continue to possess the desire and motivation to actively engage in communicative interactions (Worrall et al., 2011). For many persons with aphasia, language restoration is only partially achieved even when restorative interventions are employed (Holland & Beeson, 1993; LaPointe, 2005). An increased focus on providing intervention that considers the functional goals and social relationships of persons with aphasia has been discussed within the literature (LPAA Project Group, 2005). In particular, the “Life Participation Approach to Aphasia” (LPAA) shifts from a focus on deficits and remediation, to one that considers inclusion and participation, as persons with aphasia are affected both personally and
environmentally in the years post onset of aphasia (LPAA Project, 2005). One specific approach, compensatory intervention, focuses on the implementation of strategies and techniques to compensate for residual severe verbal expression and comprehension deficits associated with aphasia (Mollica, 1999; Rose, Raymer, Lanyon, & Attard, 2013).

Compensatory intervention programs attempt to circumvent deficits by teaching alternative ways to accomplish a specific communication objective (Mollica, 1999; White, Seckinger, Doyle, & Strauss, 1997). The goal of compensatory strategy training in patients with severe aphasia, is to increase communicative self-confidence by stimulating successful communication interactions through multiple and available modalities (Davis, 2005; Jacobs, Drew, Ogletree, & Pierce, 2004; Kagan, & Simmons-Mackie, 2007). Implementation of strategies to help individuals with severe expressive and comprehension limitations have included drawing, (Farias, Davis, & Harrington, 2006; Sacchett, Byng, Marshall, & Pound, 1999), augmentative and alternative communication (AAC) (Jacobs et al., 2004; Johnson, Hough, King, Vos, & Jeffs, 2008; Lasker, & Garrett, 2006), and use of gestures (Davis, 2005, Helm-Estabrooks, Fitzpatrick, & Barresi, 1982; Marshall et al., 2012; Rose, 2006).

Gestural interventions, used for persons with moderate and severe aphasia, is comprised of symbolic gestures that express some type of meaning, which can include iconics (e.g., hand shaped as an object, such as house), emblems (e.g., familiar actions used within a culture, such as thumbs up or salute) and pantomimes (e.g., use of objects or actions such as fork/eating) (Rose, 2006; Rose, 2013). For persons with severe aphasia and a limited prognosis for full recovery, compensatory strategies, like gestures can be considered a feasible alternative when aiding in functional communication exchanges (Caute et al., 2013; Marshall et al., 2012). Persons with severe aphasia have shown improvements in naming following a gestural communication intervention (Marshall et al., 2012). While combined gestural and verbal training interventions have resulted in improvements in verbal expression for individuals with moderate to severe aphasia (Attard, Rose, & Lanyon, 2012; Daumüller & Goldenberg, 2010; Raymer et al., 2006), limited research exists supporting the training and use of gestures in order to improve functional communication outcomes in persons with chronic, severe expressive and receptive aphasia (Marshall et al., 2012). A previous study has included methods that aimed to promote functional use of gestures (Coelho, 1991); however, only two participants were found within the study. In
addition, the researchers concluded that persons with severe aphasia were inappropriate candidates for this type of intervention (Coelho, 1991).

The effects of gesturally based intervention, in terms of facilitating comprehension, have not been recently published. However, in a past study by Helm-Estabrooks et al. (1982), eight participants with global aphasia were trained to produce symbolic gestures for visually absent pictured stimuli, demonstrated significant, positive changes in auditory comprehension, when scored using the Porch Index of Communicative Ability (PICA; Porch, 1981) (Helm-Estabrooks et al., 1982). One limitation with this particular study was that only three of the participants were found within the chronic stages of recovery. In addition, the purpose of the study was to improve overall expression, not comprehension. To date, there have been no studies examining whether gesture use would support comprehension. Therefore, research aimed to improve and support functional tasks through the use of gestural communication for persons with severe expressive and receptive aphasia is warranted.

The chronic nature of aphasia has led some researchers to suggest that rather than directing treatments solely toward the restoration of expressive and receptive communication skills, interventions for aphasia should aim to enable individuals to live successfully despite their deficit through the use of compensatory strategies (Brown et al., 2012; Holland, 2007; Kagan & Simmons-Mackie & Damico, 2007; LPAA Project Group, 2005). Despite the positive outcomes found separately within restorative and compensatory interventions, currently the research base supporting the combination of these two techniques is limited for individuals with both severe expressive and comprehension deficits associated with aphasia (Chin Li, Kitselman, Dusatko, & Spinelli, 1988; Maher et al., 2006). For this reason, the purpose of this study was to examine if a compensatory gestural treatment protocol, which employs foundational restorative principals (e.g. intensity, repetition and salience), can lead to greater comprehension and gestural expression skills in individuals with severe chronic aphasia. More specifically, this study will examine the effects of an intensive, gesturally based intervention program on comprehension and gestural production of single, categorical and personally relevant words on individuals with severe chronic comprehension and expression deficits associated with aphasia. In addition, researchers will examine the indirect results of this intervention protocol on verbal expression.
Methods

Participants

The researchers recruited study participants from a Midwest aphasia support group thus utilizing convenience sampling. Prior to study initiation the researchers obtained informed consent from each prospective participant.

Participants included four right-hand dominate adults with severe verbal expression and auditory comprehension deficits associated with aphasia. Three of these participants presented with aphasia secondary to a single left hemisphere stroke and one participant was status post non-progressive encephalopathy. All participants were required to have a communication partner that they interacted with at least once a day for five days/week who assisted in providing past medical and communication histories. Self- or communication partner-report confirmed that all participants were at least 1 year post onset of aphasia, native speakers of American English, had at least a high school education, and had negative histories of major psychotic episodes, intractable substance abuse, pre-morbid dementia or other progressive neurologic disease affecting cognition. Each participant passed a hearing screening in which he or she responded to 45dB HL tones presented at 1000, 2000, and 4000 Hz in at least one ear. The participants also passed a visual screening, which required them to match colored pictures on 9 out of 10 attempts.

Participants ranged from 26 to 159 months post-onset of aphasia (M = 71 months, SD = 62 months) at the time of study completion. The two men and two women ranged in age from 46 to 68 years (M = 58 years; SD = 12 years) and years of education ranged from 12 to 16 (M = 13; SD = 2). Standardized testing and screening measures were utilized to further describe the participant population. Table 1 provides demographic and standardized test performance information for each participant. Performance on the on the Aphasia Quotient portion of the Western Aphasia Battery-Revised (WAB-R) (Kertesz, 2006), revealed that two participants had Wernicke’s aphasia, and two had Global aphasia. WAB-R auditory verbal comprehension scores ranged from 2.6 to 6.4 (M = 4.7; SD = 1.6), suggesting that all presented with severe auditory comprehension deficits. Scores on the Apraxia Test (Van Heugten & Geusgebsm, 2004), which was used to measure the presence/severity of ideational and ideomotor apraxia, ranged from 56 to 83 (M = 69; SD = 11.6). A score of less than 86 suggests a limb apraxia, and all of the participants fell below this cut-off score (Van Heugten & Geusgebsm, 2004).
All of the participants were employed prior to acquisition of aphasia, but none had returned to work as of the time of study participation. All lived at home with assistance to perform communication tasks of daily living (e.g., speaking on the phone). None were receiving speech-language pathology services at the time of study participation.

Table 1

*Participant demographic information and standardized assessment results*

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months Post-Onset</td>
<td>71</td>
<td>26</td>
<td>159</td>
<td>27</td>
</tr>
<tr>
<td>Age</td>
<td>46</td>
<td>49</td>
<td>68</td>
<td>68</td>
</tr>
<tr>
<td>Gender</td>
<td>M</td>
<td>F</td>
<td>M</td>
<td>F</td>
</tr>
<tr>
<td>Years of Education</td>
<td>12</td>
<td>16</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Type of Aphasia</td>
<td>Wernicke</td>
<td>Global</td>
<td>Global</td>
<td>Wernicke</td>
</tr>
<tr>
<td>WAB-R Aphasia Quotient</td>
<td>61.4</td>
<td>15.5</td>
<td>24.8</td>
<td>49.2</td>
</tr>
<tr>
<td>WAB-R Auditory Verbal Comprehension Score</td>
<td>6.4</td>
<td>2.6</td>
<td>3.6</td>
<td>6.2</td>
</tr>
<tr>
<td>WAB-R Naming &amp; Word Finding</td>
<td>6.1</td>
<td>1.1</td>
<td>1.8</td>
<td>.8</td>
</tr>
<tr>
<td>Apraxia Test</td>
<td>64</td>
<td>73</td>
<td>56</td>
<td>83</td>
</tr>
</tbody>
</table>

**Design**

An ABA single case design was used to investigate the research questions by examining and comparing the effects of treatment between phases (e.g. baseline, treatment, and maintenance). This design began with observations of baseline performance with at least three
data collection sessions completed to establish stability. Nine treatment sessions were provided and probe data was collected following the third, sixth, and ninth treatment sessions. Maintenance data was recorded at 1 week, 4 weeks, and 4 months following the conclusion of the treatment phase.

**Setting**

Assessment and treatment protocols were completed at a Midwestern University Speech and Hearing Clinic. The facility provided quiet, individual and group assessment and treatment rooms that were appropriate for working with adults with aphasia.

**Materials**

Various pictorial and gestural photographs were created to be used during both the baseline and treatment phases of this study and are described in the following sections. All of the pictorial images were obtained via a Google Images © search and excluded text or brand names.

**Baseline materials.** Baseline stimuli consisted of 70 personally relevant (PR) words, which were nominated by the participant’s communication partner. Each PR word could be placed within one of the following categories; person, place, thing, food, drink, money, and time. Category selection was based on frequency of occurrence in daily activities. A corresponding colored, 6x9 in. digitally generated image was created for each of the nominated words. The colored images were presented via a laptop with a monitor of 10x15 inches.

**Treatment materials.** Treatment materials were created from the most frequently missed stimuli during the baseline phase, as well as seven specific and commonly known categories. These materials are described in the subsequent sections.

**Categorical materials.** Researchers generated digital colored images characterizing seven common categories of objects (i.e. person, place, thing, food, drink, time, and money). A corresponding single hand gesture representing each category was created and then photographed. In the pictures, a gesture was demonstrated by a female model from the waist up, in front of a plain background. Clothing worn by the model did not display any text or images. Gestures were produced by the model using the left hand and arm within the center of the body. The researchers uploaded the images onto a PowerPoint document and inserted arrows, which demonstrated the direction in which gestures were to be made. Two sets of 4x6 inch pictures of the category and corresponding gestural images were created and placed on a 4x6 inch printed card. Reliability checks were completed on the gestures created by the researchers with 100%
agreement, meaning that the gestures created, adequately represented the pictures displayed. Appendix A provides an example both a category image and gestural representation.

**Personally relevant treatment materials.** The creation and presentation of treatment stimuli followed the same protocol found within categorical stimuli development. Treatment stimuli consisted of 15 PR images, missed from the baseline phase, and their corresponding 15 gestural depictions. The 15 PR images were unique to each of the participants.

**Personally relevant control materials.** Untreated control stimuli were comprised of 15 different PR images that were missed during the baseline phase. The 15 PR images were unique to each of the participants. These 6x9 in. colored images were only shown on a computer screen od 10x15 inches during the baseline phase, treatment probes, and maintenance phase. No printed images were created for the control stimuli.

**Experimental Protocol**

**Baseline phase.** The researchers assessed the participants ability to auditory comprehend and verbally or gesturally express the 70 PR single words nominated by the communication partner. No feedback was provided to the participant directly regarding the accuracy of their responses. The protocol for the baseline phase will be discussed in the subsequent sections.

**Auditory comprehension assessment.** To assess comprehension accuracy, participants were instructed to determine if the single word, spoken by the researcher, matched the PR image being shown. Participants were shown each image three times, on nonconsecutive occasions. The stimuli were presented once with a semantically related foil, once with a phonologically related foil, and once with the PR target word. Participants were required to identify the correct target and reject the semantic and phonemic foil in order to obtain full credit for a response. (Example: Target Word: Book, Semantic Foil: Magazine, Phonemic Foil: Hook). Participants could respond to the stimuli with verbal, gestural, and/or a selected choice of visually presented written choices of ‘yes’ or no. This protocol was completed daily over the course of three days, in order to determine if performance was stable.

Following the baseline phase sessions, auditory comprehension accuracy of the 70 PR single words was calculated for each participant to determine which PR words would be included in treatment. In order to be selected, comprehension errors had to be demonstrated during at least 1 of the 3 baseline probes. The most frequently missed 30 out of the 70 PR words were selected. Once the 30 words were determined, the words were separated into two groups (15 treatment and
15 control words). In addition, the group of 30 words contained equal number of PR items representing each of the categories previously discussed. Performance accuracy for each group had to remain stable within the range of 40% or lower across the three baseline sessions.

**Verbal and gestural expression assessment.** Supplemental expression data was collected. The participants were shown each of previously selected 30 PR stimuli once on the computer screen, and researchers asked them to use whatever means of communication necessary to relay the meaning of the pictured PR object (i.e. verbal, gesture, writing, or AAC). The researchers documented the degree of accuracy and the specific method of expression used by the participant. Performance accuracy on the expression assessment was not a factor in determining participation in the study.

**Treatment phase.** The treatment phase consisted of nine treatment sessions lasting 2 hours a day, 3 days a week, for 3 weeks. Participants were broken into small groups of two, which were rotated randomly throughout the protocol. Each person with aphasia had the opportunity to interact with all of the additional participants. A modified version of Helm-Estabrooks et al (1982) *Visual Action Therapy* (VAT) protocol was implemented for the training of the category and PR stimuli gestures. One major difference from the VAT protocol was that participants were instructed on the use of seven core categorical gestures. Categories were instructed first in order to provide the participant with a reference, or a means to organize the upcoming personally relevant stimuli. The researchers wanted to ensure that the participants could make a connection between the category and PR stimuli. Implementation of the treatment protocol was conducted by two separate researchers. Reliability checks were completed daily to ensure that the two researchers followed the same protocol when teaching the category and PR stimuli/gestures to the participants. Regular breaks were provided to the participants every 45-60 minutes. The following section will discuss the eight steps used within the treatment protocol. Please refer to Figure 1 for a representation of the following treatment protocol.
Figure 1. Representation of treatment protocol.

**Training of 7 Category Stimuli**

**Step 1:**
Researchers model a gestural representation of the 7 category specific stimuli to the participants. Categories included person, place, drink, food, thing, money, and time.

**Step 2:**
Participants were required to demonstrate that they associated a gesture with the category represented.

**Step 3:**
Participants were instructed to produce appropriate representational gestures for each of the seven categories.

**Step 4:**
Researchers modeled that gestures could be represented by something not visually present.

**Step 5:**
Participants were required to gesturally produce each of the seven hidden categories.

**Step 6:**
Training of Personally Relevant Stimuli
Participants were instructed to identify categories for the PR images.

**Step 7:**
Participants were trained the participants to produce a category gesture for each PR stimuli.

**Step 8:**
Researchers showed the participants a unique PR image and then provided a modeled gesture to represent the PR image.

**Remaining PR Protocol**
Researchers utilized the same protocol from Steps 2-5 for the additional training of PR stimuli.

* The researchers utilized a modified version of Helm-Estabrooks et al. (1982) *Visual Action Therapy* protocol, for the training and treatment of the categorical and personally relevant stimuli.
**Treatment of category stimuli.** Within the first step of the protocol, the researchers demonstrated that a specific category word (i.e. person, place, thing, food, drink, time, and money) could be represented by a single-handed gesture. This was accomplished by placing seven category images on a table in front of the researcher and participants (i.e. food, drink, money, place, thing, people, and time). The researchers then provided a model of the specific category gestures using one hand while pointing to the category image that corresponded to the gesture. Multiple models of each gesture were provided to the participants. This step of the training was not scored.

During the second step, participants were required to demonstrate that he/she associated a gesture with the category represented. Each of the seven category pictures were placed in front of the participants. The researcher then produced a gesture representing one of the seven categories and silently instructed the participant to locate or point to the corresponding picture. Immediate feedback was provided to the participant regarding comprehension accuracy. Each category gesture was produced in a systematic and repetitive manner across a number of trials, until the participants provided a consistent, accurate response. The following score system was used for this portion of the treatment: 1 point – fully correct comprehension without hesitation; 0.5 points – notably delayed or self-corrected comprehension; 0 points- all other attempts. Once a score of 6.5 or better out of 7 was earned, the next step in the protocol was introduced.

The third step in the treatment focused on the production of a gesture. Participants were instructed to produce an appropriate gesture to represent each of the seven categories. One-by-one each of the seven categories were shown to the participants. Once the participants viewed the selected category image, they were required to independently produce the correct category gesture. A model was provided by the researcher if the participant demonstrated difficulty producing a gesture. If an inappropriate production was made, the researchers provided immediate feedback regarding accuracy. Multiple trials were conducted to train the participants to produce the category gestures. The following score system was used for this portion of treatment: 1 point – fully correct without hesitation or groping; 0.5 points – notably delayed (5-6 seconds) or self-corrected performance; 0 points- all other attempts. When a score of 6.5 or better, out of 7 was earned, the next step was introduced.

During the fourth step of the treatment, the researchers modeled that gestures could be represented by something not present visually. Two of the categories previously reviewed were
selected and placed on the table one at a time while the researcher produced a gesture representing the image for each. Then the two pictured categories were hidden under a folder. One pictured category was removed and the researcher produced the remaining, hidden category gesture while simultaneously pointing to the category image hidden beneath the folder. In this manner, each object took its turn remaining under the folder to be represented with a gesture until all were reviewed at least 4 times. This step of the training was not scored.

The fifth step of the treatment protocol required the participant to gesturally produce each of the seven hidden categories. Two randomly selected categories were placed on the table. The participants were instructed to produce the appropriate category gestures for each. Then, the researcher hid each of the category pictures under a folder. After about 6 seconds, one category picture was removed and the participant was required to produce a gesture for the one that remained hidden. This step was done for all possible pairs until each of the seven categories had remained hidden for the purposes of gestural production. The number of trials varied depending on the participants overall accuracy. The following score system was utilized: 1 point – fully correct production without hesitation or groping; 0.5 points – notably delayed (5-6 seconds) or self-corrected performance; 0 points- all other attempts. Once a score of 6.5 or better, out of 7 was achieved, the researchers introduced the next step.

*Treatment of personally relevant stimuli.* For each participant, a unique set of PR stimuli (15 treatment and 15 control) was instructed. At least two of the PR stimuli were represented within each of the seven frequently used categories.

During the sixth step of the treatment protocol, participants were instructed to identify the category that represented the PR images (i.e., PR Image: chicken; Category image: food). Initially, five to ten of the previously nominated PR words were introduced to the treatment protocol. Once the participants demonstrated a consistent level of performance accuracy, additional PR stimuli were trained. The seven category images were laid out on a table in front of the participant. When the researcher showed the participant a PR picture, the participant was required to correctly identify the specific category that represented the PR stimuli. If an inappropriate selection of a category was made, the researchers provided immediate feedback regarding accuracy. The following score system was used: 1 point – fully correct performance without hesitation; 0.5 points – notably delayed (5-6 seconds) or self-corrected performance; 0
points- all other attempts. A score of 13.5 out of 15 was required in order to move on the next step of treatment.

The seventh step of treatment trained the participants to produce a category gesture for each PR stimuli. One by one, each PR stimuli was shown to the participant and they were instructed to produce the correct category gesture. If the participant had difficulty producing the gesture, a model was provided. Multiple trials were completed until a steady performance was observed. The following score system was utilized: 1 point – fully correct production without hesitation or groping; 0.5 points – notably delayed (5-6 seconds) or self-corrected performance; 0 points- all other attempts. A score of 13.5 out of 15 was required in order to move on the next step of treatment.

During the eighth step of the treatment protocol, the researchers showed the participant each of the 15 unique PR treatment images and provided a modeled gesture to represent the specific PR images. Multiple models of the PR gestures were provided to the participants. This portion of the treatment was not scored.

The remaining treatment steps followed the same protocol used to instruct the category stimuli, Steps 2-5, discussed above. However, the participants were required to produce both the category and personally relevant gesture in order to receive full credit for the PR stimuli. In addition, a score of 13.5 out of 15 was required to move on to the next step of treatment. This protocol was repeated until the 3-week treatment was completed.

Throughout the protocol, participants could not advance to the next step of treatment until they had reached the level of mastery set within each respective step. In addition, participants were provided with 7 category images and the corresponding gestural images, as well as the 15 PR images and corresponding gestures to be used for home practice. All participants were encouraged to practice between sessions but data was not collected on the amount and degree of individual practice.

**Treatment probe sessions.** Treatment probe data was collected at the end of the third, sixth, and ninth treatment sessions. Participants were assessed on a one-on-one basis for this portion of the study. The protocol for probe data collection for comprehension, gestural expression, and verbal expression followed a similar format used during the baseline phase. However, during the assessment of gestural comprehension the researchers provided the participants with a gesture to accompany each of the spoken PR treatment words and their
respective semantic and phonemic foils. In addition, only the 15 PR treatment and 15 PR control stimuli were assessed. When expression data was collected the participants were again encouraged to use any means (i.e. verbal or gestures) to express the given category or PR stimuli. This instruction was only provided at the beginning of the assessment. No verbal feedback on performance was provided to the participants.

**Maintenance phase.** In order to determine whether the personally relevant and category stimuli were retained from the treatment phase, participants were assessed in three maintenance sessions. The protocol for this phase mirrored what was used within the treatment probe phase; however, sessions took place 1 week, 4 weeks, and 4 months post conclusion of the treatment phase.

**Data Analysis**

The researchers analyzed the data at different points throughout the duration of this study. The first assessment was made by determining whether an increase in performance was observed following the initiation of treatment through a visual inspection of the data. The following measures were utilized to evaluate the data (Kazdin, 2011): (1) changes in means across phases: a shift in the rate/accuracy of performance between the baseline, treatment, and maintenance phases; (2) changes in level across phases: a distinct variation in performance between phases; (3) changes in trend or slope: tendency of the data to demonstrate an increase or decrease over time; and (4) latency of the change: the amount of time between the onset of a variable and a demonstrated variation in performance.

In addition, effect size (ES) measurements were compared between pre-treatment and post-treatment performance. The ES was calculated by subtracting the mean of the three pre-treatment baseline values ($A_1$) from the mean of the three post-treatment baseline values ($A_2$) and dividing by the standard deviation of $A_1$ (Beeson & Robey, 2006). The determination of effect size significance in single case designs has come into question in recent literature (Beeson & Robey, 2006). In the past, effect sizes were discussed in terms of a criterion set by Cohen (1988). Small, medium, and large effect sizes were 0.2, 0.5, and 0.8 respectively (Cohen, 1988). However, findings from Cohen (1988) were originally based on findings within the field of psychology. Within recent research findings have suggested that Cohen’s (1988) effect sizes may not correlate to those found within aphasia research (Beeson & Robey, 2006). Additional studies were examined specifically within the area of aphasia treatment (Robey, Schultz, Crawford, &
Sinner, 1999), particularly for alexia and agraphia (Beeson & Egnor, 2006; Beeson, Magloire, & Robey, 2005). Findings provided a starting point for comparison of effect sizes with the criteria of 2.6, 3.9, and 5.8, corresponding to small-, medium-, and large-sized effects respectively (Robey, Schultz, Crawford, & Sinner, 1999). For the purposes of the present study, effect size significance followed the criteria set by Robey et al. (1999).

Results

This section provides an overview of the participants’ response to a comprehension and expressive gestural communication treatment.

Gestural Comprehension - Response to Treatment.

Findings for the comprehension of seven category specific gestures are discussed across treatment, probe, and maintenance sessions. Additional findings for the 15 treatment and 15 control PR stimuli are provided in detail.

Category specific gestural comprehension - response to treatment. Results for each participant are discussed regarding performance during treatment, probe, and maintenance sessions for comprehension of the seven category specific gestures. No baseline data is reported. Table 2 provides a detailed representation of daily comprehension treatment, probe, and maintenance performance.

Participant 1. A steady increase in gestural comprehension percentage accuracy was observed over six treatment sessions where 100% accuracy was obtained. Performance was maintained throughout the remaining treatment sessions. In addition, participant 1 demonstrated a stable performance in percentage accuracy across the maintenance phase.

Participant 2. Over six treatment sessions a steady increase in gestural comprehension percentage accuracy was noted and 100% accuracy was obtained. This performance accuracy was maintained across treatment sessions. A decrease in percentage accuracy was observed and continued through the remainder of the maintenance phase.

Participant 3. A steady performance in gestural comprehension percentage accuracy was noted over six sessions. There was a sharp increase in performance and 100% accuracy was reached within the seventh session, which maintained through the remainder of treatment. A slight decrease in percentage accuracy was observed and remained stable within the maintenance phase.
Participant 4. Across five treatment sessions, a gradual increase in gestural comprehension percentage accuracy was observed and 100% accuracy was obtained. Performance maintained throughout the treatment sessions. Participant 4 demonstrated a steady decline in gestural comprehension percentage accuracy during the maintenance phase.
Table 2

Category specific data average percent correct responses during a gestural comprehension task across treatment, probe, and maintenance phases for all participants

<table>
<thead>
<tr>
<th>Session Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>P-1</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>P-2</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>P-3</th>
<th>M-1</th>
<th>M-2</th>
<th>M-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>89%</td>
<td>71%</td>
<td>93%</td>
<td>100%</td>
<td>99%</td>
<td>93%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>71%</td>
<td>71%</td>
</tr>
<tr>
<td>Participant 2</td>
<td>60%</td>
<td>57%</td>
<td>81%</td>
<td>14%</td>
<td>95%</td>
<td>96%</td>
<td>100%</td>
<td>57%</td>
<td>100%</td>
<td>86%</td>
<td>100%</td>
<td>57%</td>
<td>43%</td>
<td>43%</td>
<td>29%</td>
</tr>
<tr>
<td>Participant 3</td>
<td>64%</td>
<td>65%</td>
<td>*</td>
<td>71%</td>
<td>69%</td>
<td>68%</td>
<td>79%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>86%</td>
<td>86%</td>
</tr>
<tr>
<td>Participant 4</td>
<td>79%</td>
<td>82%</td>
<td>82%</td>
<td>86%</td>
<td>88%</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>71%</td>
<td>86%</td>
<td>71%</td>
<td>57%</td>
</tr>
</tbody>
</table>

Note: *Data for Participant 3, during treatment session number three was not collected, as Participant 3 was absent. P= Probe session. M= Maintenance session.
**Personally relevant stimuli gestural comprehension – response to treatment.** A detailed review of participants’ accuracy on 15 treatment and 15 control PR stimuli, across baseline “A1”, treatment “B”, and maintenance “A2” phases is provided.

**Participant 1.**

*Treatment stimuli.* Participant 1 exhibited a stable performance during the baseline phase. There was an immediate positive change in level between the baseline and treatment phases for trained stimuli suggesting a response to treatment. A stable trend was noted in the treatment phase, followed by a rapid increase in performance during the last week of the intervention. A stable trend was exhibited between the treatment and maintenance phases. During the maintenance phase, a slight decrease in trend was noted following the last probe only, which occurred 4 months post treatment. An increase in the average percent accuracy on comprehension tasks across phases was observed: baseline $\bar{x} = 22\%$, treatment $\bar{x} = 80\%$, and maintenance $\bar{x} = 98\%$. Participant 1’s performance was characterized by a large effect size (effect size = 11.7) (Robey et al., 1999).

*Control stimuli.* A slight negative change in level was seen between the baseline and treatment phases. A gradual increase in trend was noted over the course of the treatment phase, which continued and then stabilized within the maintenance phase. A sudden decline in trend was observed during the last maintenance probe. An increase in the average percent accuracy on comprehension tasks across phases was observed: baseline $\bar{x} = 33\%$, treatment $\bar{x} = 36\%$, and maintenance $\bar{x} = 51\%$. No change in effect size was observed across sessions (Robey et al., 1999).
Figure 2: Participant 1’s average percent correct responses during an auditory and gestural comprehension task across baseline, treatment, and maintenance phases.

During the baseline phase, treatment and control stimuli was presented by only auditory means. During the treatment and maintenance phases, auditory and gestural stimuli was presented simultaneously.

Participant 2.

Treatment stimuli. Performance revealed a stable baseline. Participant 2 exhibited a positive shift in level, which was accompanied rapid response to the initiation of treatment. A stable, followed by an increasing trend was noted during the treatment phase. A negative shift in level was seen between the treatment and maintenance phases. Gradual improvement with an increasing, followed by a slight decrease, in trend was demonstrated in the maintenance phase. An increase in the average percent accuracy on comprehension tasks between the baseline and maintenance phases was observed: baseline $\bar{\chi} = 0\%$, treatment $\bar{\chi} = 44\%$, and maintenance $\bar{\chi} = 33\%$. Participant 2’s performance was characterized by a large effect size (effect size = 7.2) (Robey et al., 1999).

Control stimuli. Performance revealed a stable baseline with no change in level between the baseline and treatments phases. An increasing trend during the treatment phase was followed by stabilization. A rapid negative shift in level was observed between the treatment and maintenance phases. An average increase in the mean was seen between the baseline and treatment phases, followed by a decrease between the treatment and maintenance phases:
baseline $\overline{\chi} = 0\%$, treatment $\overline{\chi} = 20\%$, and maintenance $\overline{\chi} = 5\%$. No change in effect size was observed across sessions (Robey et al., 1999).

Figure 3: Participant 2’s average percent correct responses during an auditory and gestural comprehension task across baseline, treatment, and maintenance phases.

a During the baseline phase, treatment and control stimuli was presented by only auditory means.

b During the treatment and maintenance phases, auditory and gestural stimuli was presented simultaneously.

**Participant 3.**

*Treatment stimuli.* Participant 3 demonstrated an increasing followed by a stable baseline trend. A positive shift in level was seen once intervention was initiated between the baseline and treatment phases. A slight decrease in trend followed by sudden increase in performance was seen during the last treatment session. A stable pattern was exhibited between the treatment and maintenance phases. This continued through the maintenance phase until the final decline in the last session. An increase in the average percent accuracy on comprehension tasks across phases was observed; baseline $\overline{\chi} = 31\%$, treatment $\overline{\chi} = 64\%$, and maintenance $\overline{\chi} = 84\%$. Participant 3’s performance was characterized by a medium effect size (effect size = 5.2) (Robey et al., 1999).

*Control stimuli.* A stable baseline was observed. During the treatment phase, performance remained stable. There was a rapid decline towards the end of the maintenance phase. An increase in the average percent accuracy on comprehension tasks between the baseline
and maintenance phases; baseline $\bar{x} = 38\%$, treatment $\bar{x} = 49\%$, and maintenance $\bar{x} = 49\%$.

No change in effect size was observed across sessions (Robey et al., 1999).

![Graph](image)

**Figure 4:** Participant 3’s average percent correct responses during an auditory and gestural comprehension task across baseline, treatment, and maintenance phases.

a During the baseline phase, treatment and control stimuli was presented by only auditory means.

b During the treatment and maintenance phases, auditory and gestural stimuli was presented simultaneously.

**Participant 4.**

*Treatment stimuli.* Participant 4 presented with a stable baseline. A significant positive shift in level between the baseline and treatment phases in response to treatment was observed. A rapid positive change in performance was observed, along with an accelerating trend in the treatment phase. A minimal negative shift in level was demonstrated between the treatment and maintenance phases accompanied by a decrease in trend. An increase in the average percent accuracy on comprehension tasks across phases was observed: baseline $\bar{x} = 7\%$, treatment $\bar{x} = 67\%$, and maintenance $\bar{x} = 64\%$. Participant 4’s performance was characterized by a large effect size (effect size = 7.9) (Robey et al., 1999).

*Control stimuli.* Participant 4 exhibited a stable baseline. There was a positive shift in level between the baseline and treatment phases. A rapid positive change in performance was observed which led to a stabilizing trend within the treatment phase. A minimal positive shift in level was demonstrated between the treatment and maintenance phases accompanied by an
overall decrease in trend. An increase in the average percent accuracy on comprehension tasks between baseline and maintenance phases was observed: baseline $\bar{X} = 13\%$, treatment $\bar{X} = 38\%$, and maintenance $\bar{X} = 38\%$. No change in effect size was observed across sessions (Robey et al., 1999).

Figure 5: Participant 4’s average percent correct responses during an auditory and gestural comprehension task across baseline, treatment, and maintenance phases.

Expressive Gestural Communication - Response to Treatment.

Treatment findings for expression of the seven category specific gestures are discussed first within this section. This is followed by a report on gestural expression findings for the 15 treatment and 15 control PR stimuli.

Category specific gestural expression - response to treatment. Results for each participant are discussed regarding performance during treatment, probe, and maintenance sessions for expression of the seven category specific gestures. No baseline data is reported. Table 3 provides a detailed representation of daily expression treatment, probe, and maintenance performance.

Participant 1. A steady increase in gestural expression percentage accuracy was noted across four treatment sessions where 100% accuracy was obtained. Performance was maintained
throughout the remaining treatment sessions. Participant 1’s gestural expression accuracy remained relatively stable during the maintenance phase.

**Participant 2.** A steady increase in gestural expression percentage accuracy was noted over six sessions where 100% accuracy was obtained. Performance was maintained throughout the remaining treatment sessions. Participant 2’s gestural expression accuracy remained stable during the maintenance phase.

**Participant 3.** Participant 3 displayed a steady increase in gestural expression percentage accuracy, which continued until treatment session eight, where 100% accuracy was reached. This performance was maintained across the remaining treatment sessions. Performance revealed an overall decrease in gestural expression accuracy during the maintenance phase.

**Participant 4.** A steady increase in gestural expression percentage accuracy was noted over six sessions where 100% accuracy was obtained. Performance was maintained throughout the remaining treatment sessions. Participant 4 demonstrated a steady decline in gestural expression percentage accuracy during the maintenance phase.
Table 3

*Category specific data average percent correct responses during an expressive gesture task across treatment, probe, and maintenance phases for all participants*

<table>
<thead>
<tr>
<th>Session Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>P-1</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>P-2</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>P-3</th>
<th>M-1</th>
<th>M-2</th>
<th>M-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant 1</td>
<td>52%</td>
<td>74%</td>
<td>87%</td>
<td>86%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>93%</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>86%</td>
<td>**</td>
<td>100%</td>
</tr>
<tr>
<td>Participant 2</td>
<td>29%</td>
<td>45%</td>
<td>75%</td>
<td>71%</td>
<td>81%</td>
<td>86%</td>
<td>100%</td>
<td>100%</td>
<td>79%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>71%</td>
</tr>
<tr>
<td>Participant 3</td>
<td>29%</td>
<td>49%</td>
<td>*</td>
<td>43%</td>
<td>55%</td>
<td>60%</td>
<td>86%</td>
<td>100%</td>
<td>93%</td>
<td>100%</td>
<td>100%</td>
<td>86%</td>
<td>100%</td>
<td>14%</td>
<td>57%</td>
</tr>
<tr>
<td>Participant 4</td>
<td>57%</td>
<td>77%</td>
<td>71%</td>
<td>0%</td>
<td>79%</td>
<td>86%</td>
<td>100%</td>
<td>86%</td>
<td>79%</td>
<td>93%</td>
<td>100%</td>
<td>86%</td>
<td>71%</td>
<td>43%</td>
<td>29%</td>
</tr>
</tbody>
</table>

*Note:* *Data for Participant 3, during treatment session number three was not collected, as Participant 3 was absent. ** Second maintenance phase data for Participant 1 gestural expression was not collected and is not reported within the graph. P= Probe session. M= Maintenance session.*
**Personally relevant stimuli gestural expression – response to treatment.** Results for expressive gestural communication are reported for the production of both a category (C) and personally relevant (PR) gesture. Additional findings for expression of a category gesture alone and a personally relevant gesture alone are discussed briefly. However, phase means and effect size were only calculated for the production of both a C and PR gesture. Each of the participants varied in the number of PR gestures that were trained in terms of production. While participants 1 and 2 were trained to produce all 15 PR stimuli, respectively, participant 3 was not trained any PR gestures, and participant 4 was trained on 6 PR gestures.

**Participant 1 - treatment stimuli.**

*Category and PR production.* Participant 1 presented with a stable baseline. There was no change in level between the baseline and treatment phases. There was a gradual accelerating slope in the treatment phase. There was no shift in level between the treatment and maintenance phases. During the maintenance phase, a decrease in trend was observed. An increase in the average percent accuracy and usage of gestures across phases was observed: baseline $\bar{\chi} = 0\%$, treatment $\bar{\chi} = 9\%$ and maintenance $\bar{\chi} = 23\%$. No change in effect size was observed across sessions (Robey et al., 1999).

*Category production alone.* Participant 1 presented with a stable baseline. There was no change in level between the baseline and treatment phases. A gradual increase in trend was observed during the treatment phase. This was followed by a decrease in trend within the maintenance phase.

*PR production alone.* Participant 1 demonstrated a stable baseline. A rapid increase in trend was observed following the second treatment probe. A negative shift in level was seen between the treatment and maintenance phases. This was followed by a gradual increase in trend during the maintenance phase.

**Participant 1 - control stimuli.**

*Category and PR production.* Performance revealed a stable baseline. No change in level or trend was noted between the baseline and treatment phases. During the maintenance phase, a slight, minimal acceleration in trend was observed. The average percent accuracy and usage of gestures across phases was stabled with a noted slight increase during the maintenance phase: baseline $\bar{\chi} = 0\%$, treatment $\bar{\chi} = 0\%$, and maintenance $\bar{\chi} = 4\%$. No change in effect size was observed across sessions (Robey et al., 1999).
**Category production alone.** Participant 1 demonstrated a stable baseline. No change in level was seen between the baseline and treatment phases. A minimal increase in trend was observed in the third treatment probe. There was a negative shift in level between the treatment and baseline phases. A gradual increase in trend was seen during the maintenance phase.

**PR production alone.** Participant 1 demonstrated a stable baseline. No change in level was seen between the baseline and treatment phases. A minimal increase in trend was observed in the third treatment probe. There was a negative shift in level between the treatment and baseline phases. A slight, gradual increase in trend was seen during the maintenance phase.

![Graph](image.png)

**Figure 6:** Participant 1’s average percent correct responses during an expressive gestural communication task across baseline, treatment, and maintenance phases. Second maintenance phase data for gestural expression was not collected and is not reported within the graph.

**Participant 2 - treatment stimuli.**

**Category and PR production.** Participant 2 presented with a stable baseline. There was no change in level between the baseline and treatment phases. A rapid increase in trend was observed during the treatment phase, which stabilized between the treatment and maintenance phases. A gradual increase in trend continued throughout the maintenance phase. An increase in the average percent accuracy and usage of gestures across phases was observed: baseline $\bar{X} = 0\%$, treatment $\bar{X} = 33\%$ and maintenance $\bar{X} = 82\%$. Participant 2’s performance was characterized by a large effect size (effect size = 11.4) (Robey et al., 1999).
Category production alone. Participant 2 demonstrated a stable baseline. There was no change in level between the baseline and treatment phases. A rapid increase in trend was observed following the first treatment probe and remained relatively stable across the remaining treatment probes and into the first maintenance probe. An increase in trend was followed by stabilization within the maintenance phase.

PR production alone. Participant 2 presented with a stable baseline. There was no change in level between the baseline and treatment phases. A rapid increase in trend was observed during the treatment phase, which stabilized between the treatment and maintenance phases. A gradual increase in trend continued throughout the maintenance phase.

Participant 2 - control stimuli.

Category and PR production. Participant 2 presented with a stable baseline. No change in level was noted across phases. A gradual increase in trend was seen in the second probe session, which was followed by a gradual decline. Performance remained relatively stable during the maintenance phase. The average percent accuracy and usage of gestures across phases was stabled with a noted slight increase during the treatment phase: baseline $\bar{X} = 0\%$, treatment $\bar{X} = 7\%$, and maintenance $\bar{X} = 2\%$. No change in effect size was observed across sessions (Robey et al., 1999).

Category production alone. Participant 2 demonstrated a stable baseline. There was no shift in level between the baseline and treatment phases. A gradual increase in trend was seen following the initial treatment probe, which continued to the maintenance phase. Performance stabilized and then a gradual increase was seen during the final treatment probe.

PR production alone. Participant 2 exhibited a stable baseline. No shift in level was seen between the baseline and treatment phases. An increase in trend was immediately followed by a decrease within the treatment phase. A decrease in trend, followed by stabilization was seen in the maintenance phase.
Figure 7: Participant 2’s average percent correct responses during an expressive gestural communication task across baseline, treatment, and maintenance phases.

Participant 3 - treatment stimuli.

Category and PR production. Participant 3 demonstrated a steady baseline with no noteworthy changes in trend or level across phases. No significant change in the average mean usage of gestures was seen across phases: baseline $\overline{\chi} = 0\%$, treatment $\overline{\chi} = 0\%$, and maintenance $\overline{\chi} = 0\%$. No change in effect size was observed across sessions (Robey et al., 1999).

Category production alone. Participant 3 demonstrated a steady baseline. A rapid increase in trend was observed during the second treatment probe. This immediately followed by a decrease in trend. A positive shift in level was observed between the treatment and maintenance phases, A steady decline in trend, followed by stabilization was observed in the maintenance phase.

PR production alone. Participant 3 demonstrated a stable baseline. No noteworthy changes in level or trend were observed in the treatment phase. There was a slight positive shift in level between the treatment and maintenance phases. A steady increase in trend within the second maintenance probes was followed by a gradual decline.

Participant 3 - control stimuli.

Category and PR production. Participant 3 demonstrated a steady baseline with no noteworthy changes in trend or level across phases. No significant change in the average mean
usage of gestures was seen across phases: baseline $\bar{X} = 0\%$, treatment $\bar{X} = 0\%$, and maintenance $\bar{X} = 0\%$. No change in effect size was observed across sessions (Robey et al., 1999).

*Category production alone.* Participant 3 exhibited a steady baseline. There was a gradual increase in trend across the treatment phase. A negative shift in level was seen between the treatment and maintenance phases. A rapid decline in trend was seen following the first maintenance probe.

*PR production alone.* Participant 3 demonstrated a stable baseline. No noteworthy changes in level or trend were observed in the treatment and maintenance phases.

---

**Figure 8:** Participant 3’s average percent correct responses during an expressive gestural communication task across baseline, treatment, and maintenance phases.

*Participant 4- treatment stimuli.*

*Category and PR production.* Participant 4 exhibited a stable baseline. No change in level was seen between the baseline and treatment phases. During the treatment phase, a gradual increase in trend was followed by an immediate decrease following the second probe. Between the treatment and maintenance phases, there was a slight positive shift in level. A gradual decelerating trend was noted in the maintenance phase. An increase in the average percent accuracy and usage of gestures in the baseline and treatment phases was observed: baseline $\bar{X} = 0\%$, treatment $\bar{X} = 9\%$, and maintenance $\bar{X} = 9\%$. No change in effect size was observed across sessions (Robey et al., 1999).
Category production alone. Participant 4 exhibited a stable baseline. A positive shift in level was observed between the baseline and treatment phases. A gradual increase in trend was stabilized across the second and third treatment probes. A positive shift was seen between the treatment and maintenance phases. This was followed by a rapid decline in trend across the maintenance phase.

PR production alone. Performance revealed a stable baseline. No change in level was seen between the baseline and treatment phases. A gradual increase in trend was seen during the third treatment probe. There was a positive shift in level between the treatment and maintenance phases. During the treatment phase, a stable trend was followed by a gradual decline.

 Participant 4 - control stimuli.

Category and PR production. Participant 4 demonstrated a steady baseline with no noteworthy changes in trend or level across phases. No significant change in the average mean usage of gestures was seen across phases: baseline $\bar{\chi} = 0\%$, treatment $\bar{\chi} = 0\%$, and maintenance $\bar{\chi} = 0\%$. No change in effect size was observed across sessions (Robey et al., 1999).

Category production alone. Participant 4 exhibited a steady baseline. There was a gradual increase in trend seen during the last treatment probe. No shift in level was observed between the treatment and maintenance phases. A rapid decline in trend was seen following the first maintenance probe, which led to stabilization.

PR production alone. Participant 4 demonstrated a stable baseline. No noteworthy changes in level or trend were observed in the treatment and maintenance phases.
Data collected for verbal expression was analyzed as an indirect response to the gestural treatment protocol

**Participant 1.**

**Treatment stimuli.** Participant 1 demonstrated a relatively stable baseline. A negative shift in level was noted between the baseline and treatment phases. Treatment did not lead to an immediate improvement at Probe 1; however, a rapid accelerated trend followed by stabilization was then observed in the treatment phase. This was followed by a negative shift in level between the treatment and maintenance phases. An average increase in the mean was seen between the baseline and treatment phases, followed by a decrease between the treatment and maintenance phases: baseline $\overline{\chi} = 31\%$, treatment $\overline{\chi} = 60\%$, and maintenance $\overline{\chi} = 44\%$. No change in effect size was observed across sessions (Robey et al., 1999).

**Control stimuli.** Baseline performance revealed a stable baseline with no change in level between the baseline and treatments phases. A rapid increasing trend was demonstrated between probe one and probe two of the treatment phase. A positive shift in change was seen between the treatment and maintenance phase, alone with decelerating trend which continued through the maintenance phase. An increase in the average mean was demonstrated between the baseline and treatment, and was sustained within the maintenance phase: $\overline{\chi} = 31\%$, treatment $\overline{\chi} = 47\%$, and
maintenance \( \bar{X} = 47\% \). No change in effect size was observed across sessions (Robey et al., 1999).

Figure 10: Participant 1’s average percent correct responses during a verbal expression task across baseline, treatment, and maintenance phases.

**Participant 2.**

*Treatment stimuli.* Performance revealed stable baseline with no change in level between the baseline, treatment, and maintenance phases. A delayed minimal response to treatment was noted, followed by a decrease in trend. No significant change in the average mean was seen across phases: baseline \( \bar{X} = 0\% \), treatment \( \bar{X} = 2\% \), and maintenance \( \bar{X} = 0\% \). No change in effect size was observed across sessions (Robey et al., 1999).

*Control stimuli.* Participant 2 demonstrated a steady baseline with no noteworthy changes in trend or level across phases. No significant change in the average mean was seen across phases: baseline \( \bar{X} = 0\% \), treatment \( \bar{X} = 0\% \), and maintenance \( \bar{X} = 2\% \). No change in effect size was observed across sessions (Robey et al., 1999).
Figure 11: Participant 2’s average percent correct responses during a verbal expression task across baseline, treatment, and maintenance phases.

**Participant 3.**

**Treatment stimuli.** Results revealed an increasing and decreasing trend within the baseline phase. There was an upward shift in level between the baseline and treatment phases. Response to treatment remained stable with a gradual increase towards the last probe within the treatment phase. A negative shift in level was observed between the treatment and maintenance phases. Performance within the maintenance phase demonstrated a decreasing trend, which was followed by an increase within the last probe, which occurred 4 months post treatment. An increase in the average mean was demonstrated between the baseline and treatment, followed by a decrease in the maintenance phase: $\overline{X} =$ 14%, treatment $\overline{X} =$ 24%, and maintenance $\overline{X} =$ 18%. No change in effect size was observed across sessions (Robey et al., 1999).

**Control stimuli.** Participant 3 demonstrated a stable baseline. A minimal negative shift in level was noted between the baseline and treatment phases. During the treatment phase, a gradual increase in trend was observed. There was a negative shift in level between the treatment and maintenance phases, and performance within the maintenance phase remained stable. An increase in the average mean was demonstrated between the baseline and treatment, followed by a decrease in the maintenance phase: $\overline{X} =$ 2%, treatment $\overline{X} =$ 7%, and maintenance $\overline{X} =$ 0%. No change in effect size was observed across sessions (Robey et al., 1999).
Figure 12: Participant 3’s average percent correct responses during a verbal expression task across baseline, treatment, and maintenance phases.

Participant 4.

Treatment stimuli. Participant demonstrated a relatively stable baseline. A negative shift in level was exhibited between the baseline and treatment phases. Treatment did not lead to an immediate response, and a mild accelerating trend was noted in the treatment phase. This was followed by a decrease in trend, which continued through to the maintenance phase. An increase in the average mean was demonstrated between the baseline and treatment, while a decrease was seen in the maintenance phase: $\bar{x} = 11\%$, treatment $\bar{x} = 11\%$, and maintenance $\bar{x} = 7\%$. No change in effect size was observed across sessions (Robey et al., 1999).

Control stimuli. Performance revealed a relatively stable baseline. Between the baseline and treatment phase there was negative shift in level. Treatment did not lead to an immediate change as the trend remained stable; however, an accelerating trend was seen in the third treatment probe. At the completion of treatment, a negative shift in level was demonstrated. Performance remained stable within the maintenance phase. A decrease in the average mean was exhibited between the baseline and treatment, while an increase was seen in the maintenance phase: $\bar{x} = 7\%$, treatment $\bar{x} = 2\%$, and maintenance $\bar{x} = 5\%$. No change in effect size was observed across sessions (Robey et al., 1999).
Severe, chronic expressive and auditory comprehension deficits can negatively affect an individual’s ability to engage in daily communication activities. While restorative interventions have resulted in positive comprehension and expression gains in persons with severe chronic aphasia (Cherney, Patterson, Raymer, Frymark, & Schooling, 2008; Knollman-Porter et al., 2015; Robey, 1998), residual deficits often remain. Therefore, the primary purpose of this study was to determine whether the combination of restorative (e.g. intensity, repetition, and salience) and compensatory gestural treatment principals would result in improvements in comprehension and expression of single personally relevant words for persons with chronic, severe aphasia.

For all participants within this study, increased comprehension was exhibited when gestures were presented simultaneously with spoken single personally relevant words. More specifically, a medium to large effect size was demonstrated for all participants suggesting that gesture use can support greater understanding in individuals with severe chronic aphasia. While supportive expressive communication strategies have been frequently analyzed in the literature (Davis, 2005; Farias et al., 2006; Helm-Estabrooks et al., 1982; Jacobs et al., 2004; Johnson et al., 2008; Lasker, & Garrett, 2006; Marshall et al., 2012; Rose, 2006; Sacchett et al., 1999), the results from this study are unique in that it provides evidence for the use of supportive

Figure 13: Participant 4’s average percent correct responses during a verbal expression task across baseline, treatment, and maintenance phases.
comprehension strategies for individuals with chronic aphasia. Auditory comprehension, in the chronic phases of recovery can continue to significantly impact the lives of individuals with aphasia (Knollman-Porter et al., 2015; Paolucci et al., 2005). For example, when analyzing baseline and early treatment results, each of the participants demonstrated difficulty comprehending words associated with gender (i.e. man vs. woman). Failure to understand this concept can lead to breakdowns in the comprehension of basic information relayed about family, friends, or colleagues. Following the implementation of gesture instruction to represent these terms, improvements in comprehension for the concept of gender were observed. As with other supportive expressive techniques (i.e., AAC, drawing) results of this study suggest that gestures can be used as a method of support, not a replacement for auditorily presented information.

Positive findings in the gestural production of single personally relevant images were also revealed across participants within the present study, but not to the same degree as in comprehension. More specifically, a large effect was demonstrated by 1 participant, while 3 participants exhibited no effect in the production of combined category and PR gestures. One possible reason for the lack of significant change in production across all participants could be the unique nature of their individual deficits. Even though all were classified according to standard aphasia assessment batteries as having severe expressive and comprehension deficits and co-occurring limb apraxia, each individual presented with key strengths and limitations. For example, Participant 2 excelled in her ability to acquire and produce gestures even though she presented with profound global aphasia. The use of gestures provided her an avenue of expression that had not been possible since her acquisition of aphasia and she eagerly desired to learn more in order to communicate. These results contradict past findings which suggest that a gestural communication program may not be appropriate for individuals with severe aphasia (Coelho, 1991). In contrast, other participant gains were not as robust secondary to varying degrees of co-occurring limb apraxia, an impairment of learned, skilled limb movements, which can hinder the ability to use gestures effectively to communicate (Hogrefe, Zeigler, Weidinger, & Goldenberg, 2012; Rothi, Ochipa, & Heilman, 1997). More specifically, participant 3, who presented with the greatest degree of limb apraxia, exhibited improvements in the production of single category gestures, but could not fluidly produced a combined categorical and PR gesture. It should be noted, that in order to acquire gestures he required increased instruction time; hence, fewer gestures were learned over a greater amount of time when compared to other participants.
These findings suggest that dosage for treatments, even involving individuals with severe aphasia may be variable and should be determined based on many factors that are unique to the individual. In addition, for persons within the chronic stages of severe aphasia who present with coinciding limb apraxia may not be able to produce a large sample of gestures. However, the instruction of a small set of specific personally relevant gestures should not be ruled out, as this explicit training could still aid in providing a reference for communication partners regarding specific functional needs that cannot be expressed verbally.

One functional component within the present study that is noteworthy to discuss relates to the use of categorical and personally relevant stimuli. This element was unique to the present study, as past gestural intervention has utilized personally relevant stimuli; however, gains within personally relevant stimuli were not found to be as large when compared to standard stimuli (Marshall, 2012). While the production of both a category and personally relevant gesture did not result in large effects across participants, gains within production of either a category or personally relevant gesture alone was observed. During the treatment phase, each of the participants were able to establish consistent accuracy in productions of category gestures. In addition, performance on production of PR stimuli alone was noted to maintain or improve across all of the participants within the treatment and maintenance phases. By allowing each of the participants to select their own personally relevant stimuli, increases in overall motivation and function are possible (Wepman, 1953; Worrall et al., 2011).

Following the analysis of gestural production, the researchers observed whether the use of gestures would generalize or indirectly increase the participant’s verbal expression abilities. Verbal expression skills were not found to improve, as no change in effect was seen across all participants following treatment. While the combination of gestural and verbal interventions have led to gains in verbal expression within past literature (Attard, Rose, & Lanyon, 2012; Marshall et al., 2012; Raymer et al., 2006), the participants found within these given studies did not consistently present with chronic, severe expressive and receptive deficits. In addition, for this purpose of this study, direct verbal instruction was not provided. Hence, further research is warranted to determine if a combined gestural and verbal instruction protocol can lead to gains in individuals with severe chronic expressive and comprehension deficits associated with aphasia. However, due to the decrease in carryover of treatment for verbal expression observed in this
study, it can be suggested that personally relevant gestures may serve as an alternative form of expression for persons with severe, chronic receptive and expressive aphasia.

**Limitations and Future Directions of Research**

Aphasia is a problem that not only affects the individual, but the family as well (Holland, 2007). Given the chronic nature of aphasia, recommendations have said that individuals do not just “get over” (p. 341) aphasia, but instead should attempt to incorporate the residual outcomes into their daily lives (Holland, 2007; Kagan, & Simmons-Mackie, 2007). Caregivers can be a valuable asset within the rehabilitation process because they are most familiar with their family member and can assist in the recovery process outside of the therapy room (Brown et al., 2012). Interventions should respect caregivers “expertise” (p. 341) and allow them to play a meaningful role in their partners rehabilitation process (Holland, 2002). Although the present study utilized personally relevant stimuli, selected by the participant’s communication partners, with a goal of improving functional comprehension, generalization of learned skills in treatment to the participants’ home and outside environments was not measured. Additional support in encouraging carryover, home practice, and the incorporation of gestures within real-world activities should be measured in future studies. Moreover, the researchers did not assess how the communication partners felt about the influence the gestural intervention program had on the participants. Future research should examine the extent to which personally relevant gestural stimuli can be carried over into functional communication activities of daily living for individuals with severe, chronic auditory comprehension and expression deficits.

An additional functional element within the present treatment protocol related to the group setting. Group based interventions in particular have been found to increase participation in conversation as well as improve scores on language tests within past literature (Elman & Bernstein-Ellis, 1999a, 1999b). Within this study, the small group intervention setting presented both challenges and benefits. The original intention for the implementation of a small group intervention was to consider cost effectiveness; however, the researchers within the present study later questioned whether an individualized therapy would have resulted in alternative outcomes. Participants were paired together based on the similarities between their age, gender, and aphasia type. While all of the participants presented with severe expressive and receptive deficits based on formal testing batteries, individual differences within these groups resulted in a need to pair groups differently. Some of participants made gains at a faster pace, others, in particular
participant 3 and 4, struggled and progressed through the treatment protocol at a slower rate. When group interventions are employed, participants may benefit by being paired with individuals that progress at similar rates in order to increase a supportive and encouraging treatment environment. A noteworthy point to mention was that during an informal conversation, each of the participants expressed that they enjoyed working with other individuals. However, subjective data regarding participant’s feelings towards the group intervention setting was not formally collected. Future research should consider the use of group treatment protocols with an emphasis on matching participants by the similarities of deficits and skill level, in order to potentially increase functional outcomes.

While findings from the present study have revealed positive findings in comprehension and gestural expression for persons with chronic aphasia, the impacts of this protocol on an acute population are unknown. The use of gestures within the acute and sub-acute phases of recovery has proven to be effective on gestural expression (Daumüller & Goldenberg, 2010); however, stimuli were selected by the researchers, not the participants themselves. Future research should consider the implementation of the present treatment protocol within the early stages of intervention, in order to determine whether improvements in long-term patient care planning benefits, and carryover effects on comprehension and expression exist.

Conclusion

The present investigation determined that an intensive, gesturally based small group intervention protocol using personally relevant stimuli could improve comprehension and gestural expression in persons with chronic, severe deficits secondary to aphasia. Speech language pathologists should consider training categorical and personally relevant gestures when providing treatment to persons with severe, chronic expressive and receptive deficits, as they relate to daily activities of living. In addition, the implementation of a group based, intensive intervention program could result in greater functional outcomes for persons with chronic, severe aphasia. The findings from the present study suggest that further research in assessing carryover with the use of personally relevant gestures in functional settings is warranted.
References


and cognition: Studies of normal aging and brain damage (pp. 109 – 116). New York: Springer US.


Appendix A

Category Specific Image for Money

Category Specific Gestural Depiction for Money

Money