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THE FACILITATIVE EFFECTS OF DRAWING AND GESTURING ON WORD RETRIEVAL FOR PEOPLE WITH APHASIA

by

Morgan Elaine Enright

A thesis submitted in partial fulfillment
of the requirements for the Master of Arts
degree in Speech Pathology and Audiology in the
Graduate College of
The University of Iowa

May 2015

Thesis Supervisor: Associate Professor Jean K. Gordon

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Graduate College
The University of Iowa
Iowa City, Iowa

CERTIFICATE OF APPROVAL

MASTER'S THESIS

This is to certify that the Master's thesis of

Morgan Elaine Enright

has been approved by the Examining Committee for
the thesis requirement for the Master of Arts degree
in Speech Pathology and Audiology at the May 2015 graduation.

Thesis Committee: ___________________________________
Jean K. Gordon, Thesis Supervisor

____
Melissa Duff

____
Alison Lemke

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ABSTRACT

In order to verbally communicate successfully, people need the ability to retrieve a desired word. However, the inability to do this, called "anomia," is a common impairment for people with aphasia, and frequently persists into the chronic stage of recovery. Strategies that facilitate verbal expression may reduce or compensate for instances of anomia. Verbal strategies, such as Semantic Feature Analysis (SFA) have been researched extensively and shown to be effective. Nonverbal strategies, such as drawing and gesture, have research on their effects as a substitution for verbalization, but less on their facilitative effects. However, the research suggests they may work in a similar manner to verbal approaches, by activating semantic networks. Thus, the facilitative effects of nonverbal strategies should be explored further. The aim of this experiment was to determine the facilitative effects of drawing and gesturing during a picture naming task in one participant with chronic aphasia. Results revealed that all conditions evaluated, drawing, gesture, and wait (control), produced improvements in the picture naming task. However, contrary to expectations, the facilitated conditions (i.e. drawing and gesture) did not create more effects than the unfacilitated condition (i.e. wait). This finding may indicate the benefits of a factor common to all conditions. Further results of this study and directions for future research are discussed.

PUBLIC ABSTRACT

The inability to retrieve words while talking, referred to as "anomia", is a common impairment in individuals with aphasia, a language impairment resulting from a stroke. Even when other language deficits resolve, anomia often persists. When anomia occurs frequently, it significantly impairs a person's ability to efficiently and effectively communicate his or her basic wants and needs, as well as independently participate in social activities. Research is needed to identify effective ways to reduce instances of anomia and thus increase a person's ability to communicate successfully. It has been suggested that drawing may increase a person's ability to retrieve a desired word, thus decreasing anomia. In this study, a participant with aphasia drew or gestured a picture that he was originally unable to name. Researchers assessed whether drawing and/or gesturing improved his ability to retrieve the name of the picture, when compared to a wait (i.e. control) condition. Contrary to expectations, results indicated that drawing and gesture did not create more improvements on the picture naming task than the wait condition. More specific results and potential ways to further this area of research are discussed.

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Introduction

Approximately one million people in the United States have aphasia, and approximately 200,000 acquire the disorder each year (National Aphasia Association, 2011). Aphasia is often chronic (Sarno, 1991), defined as persisting for longer than one year after the onset of symptoms (Moss & Nicholas, 2006). This shows that speech-language pathology services are not completely effective at resolving the symptoms of aphasia. The most common symptom of aphasia is anomia, a disorder in which people have difficulty retrieving words from their mental lexicon (Taylor & Hough, 2013).

Although anomia is a significant problem for people with aphasia (PWA), insurance-covered services often end while these deficits remain. For that reason, PWA need a strategy to enhance word retrieval that they can carry out independently. Here, we distinguish treatment, what the speech-language pathologist (SLP) does with a PWA during a therapy session to enact long-term change, from strategies, actions undertaken to promote success in the moment. Strategies can be clinician-directed, such as a cueing hierarchy, or directed by the PWA. An additional important distinction is between facilitative and compensatory strategies. Facilitative strategies are used to stimulate normal language processes, while compensatory strategies work around the deficit by using means other than normal language processes (American Speech-Language-Hearing Association, 2003; La Pointe, 2011).

This experiment was completed in order to assess the facilitative effects of drawing and gesture on verbal expression. Drawing as a strategy to facilitate speech may be particularly desirable because PWA may be reluctant to use alternative or augmentative forms of communication as a substitution for speech. They may fear that they are "giving up" on improving verbal expression. However, combining drawing or gesture with residual language abilities may be more acceptable to PWA and enhance verbal output (Farias, 2006). This use of drawing has only recently been investigated, so there is limited available research and what is available typically involves small sample sizes or case studies.

Verbal Approaches for Word Retrieval

Various verbal strategies can be used to address anomia. A cueing hierarchy is a common way that clinicians can facilitate word retrieval for PWA. Clinicians can employ a variety of cues in a hierarchy, including providing a description of the target word (e.g. "It's something you use to cook bread in the morning") or providing the first sound (e.g. "It's a t-…"). Initial phoneme cues are most effective, as they provide a cue to the word's phonological form (Pease & Goodglass, 1978). Unfortunately, Goodglass (1997) explains that most PWA cannot provide these helpful cues for themselves.

Semantic Feature Analysis (SFA) is a common semantically based treatment for word retrieval impairments. It aims to access and increase activation in semantic networks in order to improve lexical retrieval (Boyle & Coelho, 1995). SFA requires the PWA to produce semantically related information about a target word, usually in the following categories: semantic category, category coordinate, use, action or function, properties, and location (Coelho, McHugh, & Boyle, 2011). By activating these features of the target word, it is hypothesized that the target word is also activated via spreading activation (Collins & Loftus, 1975). An additional benefit of SFA is that once a PWA is trained in principles of this strategy, he or she could, potentially, use this strategy independently as a means of circumlocution to compensate for word retrieval failures.

Boyle and Coelho (1995) showed that, for one PWA, SFA improved accuracy on a confrontation naming task, with generalized improvement to untreated stimuli. This generalization finding suggests that at least some of the untreated stimuli were related to the treated stimuli, as unrelated untreated stimuli would not be expected to show generalization. Boyle and Coelho (1995) speculate that SFA works because the PWA is required to generate the target-related information him- or herself, with the therapist providing information only as a final resort. A recent review of the research examined whether SFA improves confrontation naming abilities for patients with non-degenerative aphasia (Maddy, Capilouto, & McComas, 2014). The researchers calculated effect sizes for ten studies that met their criteria of using SFA as it was initially described and including adults with neurological damage. The researchers found a medium to large treatment effect for the trained stimuli with limited generalization to untrained stimuli or connected speech. However, the researchers do not say whether the untrained stimuli were related or unrelated. If the untrained stimuli were also unrelated, that could explain why generalization did not occur. With related stimuli, generalization would be expected. Researchers also speculated that other reasons for limited generalization may be that factors such as intensity and dosage have a greater effect on generalization than SFA itself.

Constraint-Induced Language Therapy (CILT) is another common verbal approach for word retrieval impairments. CILT addresses the fact that PWA typically communicate through whatever method requires the least amount of effort, which typically is not verbal output. In order to increase verbal output, CILT does not allow the PWA to utilize the less effortful compensatory strategies, such as drawing or gesture. This is accomplished through barrier tasks so that the lack of visual contact potentially minimizes the utility of nonverbal strategies. An evidence based systematic review (Cherney et al., 2008) showed that CILT is correlated with positive changes on standardized language impairment measures and communication participation in those with chronic aphasia for up to six months. However, CILT protocol also includes a high time intensity requirement, so researchers have not yet determined the effects of time intensity versus principles of CILT.

Nonverbal Approaches for Word Retrieval

Similarly to semantic approaches like SFA, nonverbal approaches such as drawing and gesture may work to activate semantic networks in the brain (Francis, Clark, & Humphreys, 2002). Francis and colleagues (2002) hypothesized that tasks which involve producing spontaneous gestures require internally driven access to the word. They describe "internally driven access" as when the PWA is required to independently access relevant semantic information and generate the gesture, as opposed to treatments that require less active effort on the part of the PWA, such as repetition or word-picture matching. Of course, this depends on how stimuli are presented. Requiring a PWA to imitate a gesture would not promote internally driven access to the word. The same logic may be applied to drawing tasks (Farias, 2006).

Gesture

Various research has suggested multiple models and hypotheses about the manner in which gesture and speech are related to each other. One relevant theoretical hypothesis suggests that gestures and speech both originate from one representation or conceptualizer in the brain (de Ruiter & de Beer, 2013). In that case, both modes communicate different but essential information.

Research has shown a close relationship between gesture and speech in typical speakers. Pine and colleagues (2010) showed that gestures serve both interpersonal and intrapersonal functions. They eliminated visual contact between a speaker and listener and found that the speaker continued to use gestures, even though he or she could not see the communication partner. The researchers concluded that this suggests that gestures have intrapersonal functions for the speakers including enhancing perception, memory, language, and problem solving. In 2013, Pine and colleagues asked typical speakers to name objects while producing either a congruent gesture, an incongruent gesture, or no gesture at all. The congruent gesture was found to facilitate word retrieval compared to the no gesture condition. By contrast, producing an incongruent gesture inhibited naming. The researchers interpreted this as evidence that gesturing is integral to the cognitive process of speaking.

Frick-Horbury & Guttentag (1998) assessed word retrieval following a semantic description during the two conditions of restricting and not restricting gestures. The researchers found that participants, who were all typical, retrieved more words when gestures were not restricted. The unrestricted participants also performed higher on a free recall task after the word retrieval task. The researchers hypothesized that following the instruction of not gesturing may have utilized valuable cognitive resources and created reduced information processing for the word retrieval task.

Gesture is also related to lexical retrieval for PWA (Carragher, Sage, & Conroy, 2013; Boo & Rose, 2011). Boo and Rose (2011) evaluated the effects of various word retrieval treatments on naming 100 actions in two individuals with chronic Broca's aphasia. The measured outcome was verb-naming accuracy. The repetition treatment, which did not support internally driven access to the word (Francis, Clark, and Humphreys, 2002) did not create any significant changes in naming accuracy. Both the semantic and the semantic-gesture treatments were effective at improving naming accuracy. However, the results from the semantic only condition were not maintained at follow-up probes, while the semantic-gesture results were maintained in one participant. Thus, the semantic-gesture treatment produced the most significant acquisition effects and maintenance effects. The researchers speculated that the inclusion of gesture may have provided a more distinct cue than a semantic cue alone, which enhanced activation of the target more than its semantically related competitors. From this study, the researchers concluded that gestures and verb retrieval are highly related in PWA.

Carragher and colleagues (2013) evaluated the effects of treatment involving SFA, phonemic cueing, and gesture production. It is important to consider here that the SFA and gesture approaches did overlap. Because gestures can represent the motor components of the target, they can be utilized to facilitate the SFA categories of "Use" and "Action" and prime retrieval. The researchers found a significant improvement in verb retrieval for trained verbs that was maintained at follow-up four weeks later. Although it is difficult to separate out the results of each component of the therapy program, these results do suggest that gesture affects word retrieval.

In the past, clinicians have found it beneficial to increase PWA's use of gesture as an alternative means of communication. Various programs have been designed to increase and improve PWA's gestures, although most of them were designed for gestures to be used as a substitute for verbalization. One example of such a program is Visual Action Therapy (VAT), designed to increase production of representational gestures for functional communication and to reduce apraxia (Helm-Estabrooks & Albert, 2004). VAT teaches the three components of imitation, recognition, and production of gestures. Helm-Estabrooks, Fitzpatrick, and Barresi (1982) found that in a group of eight PWA treated with VAT, there were significant improvements of pantomimic skills (Helm-Estabrooks, Fitzpatrick, & Barresi, 1982).

The approaches that focus on increasing use, as opposed to improving recognizability, may be particularly relevant if it is found that gestures can increase word retrieval for the PWA. However, Helm-Estabrooks and colleagues (1982) found no corresponding improvements on verbal expression skills following VAT. Of course, programs designed as a substitute for verbal output do not specifically target increased verbal expression. Gesture programs such as VAT presumably focus on communicating basic needs. It is possible that the skills and/or gestures addressed in VAT are too specific to transfer to a wider variety of words, which would be necessary for the goal of facilitating overall verbal expression. Additionally, VAT is used to practice gestures in people with apraxia. Limb apraxia may negatively affect formation of the gesture and lessen the facilitative effect that it would have in speech in a person without concomitant apraxia.

Drawing

Drawing is another nonverbal strategy, which may provide several speech and non-speech benefits to PWA. First, like writing (but unlike speech or gesture), drawing provides a permanent record to which PWA and their communication partners can refer, which may lessen demands on potentially impaired memory. Second, with advances in technology, a device such as an iPad or tablet could be used to enhance communication over distance. According to Sacchett (2002), this is especially important because many methods of communication via distance, such as telephone, email, and fax, rely on verbal skills, and so are particularly difficult for PWA. Finally, also according to Sacchett (2002), drawing can serve as a type of art therapy to address psychological or emotional trauma that is common following strokes. Carvoni (2011) described how drawing helped to replace the creative outlet that a PWA lost due to problems speaking. Drawing improved his self-esteem and self-worth while decreasing his depression.

As for gesture, much of the prior research regarding drawing by PWA has focused on using drawing as a compensatory method of communication (i.e. a substitute for speech). However, due to various impairments experienced by PWA, such as limb apraxia or visual deficits, they are unlikely to use drawing spontaneously (Lyon, 1995). Additionally, it is less likely that a PWA would have habituated drawing pre-stroke, particularly when compared to other potential strategies, particularly gesture.

Therapy can focus on increasing use of drawing and/or improving the quality of drawings by instructing PWA how to incorporate additional and relevant details and depict recognizable content units (Helm-Estabrooks & Morgan, 1987; Sacchett, 2002; Taylor & Hough, 2013). For example, in Sacchett's program, PWA were encouraged to depict each action in a single panel, like a cartoon strip. Another strategy taught by Sacchett (2002) was the use of arrows to show movement or orientation.

In order to teach the skills described above and increase spontaneous use of drawing, some clinicians utilize formal treatment approaches. One formal treatment program is Back to the Drawing Board (BDB, Helm-Estabrooks & Morgan, 1987). The goal of this program, and others like it, is not artistic excellence, but drawing that is recognizable, with enough critical details to communicate a message. BDB procedures include copying cartoon stimuli from memory, with instruction provided via verbalizations and modeling from the clinician. Eventual progression is made from one- to two- and three-panel cartoons (Morgan & Helm-Estabrooks, 1987). Morgan and Helm-Estabrooks (1987) found that, for two patients with left cerebrovascular accidents (CVAs), one with global aphasia and one with severely non-fluent output, who were both at least one year post-onset, BDB resulted in improvements in drawing that significantly improved a judge's ability to describe the picture accurately. Overall, the researchers concluded that following BDB helped the PWA learn to convey information using only drawing.

As opposed to utilizing drawing only as a substitute for verbal output, drawing has recently been considered as a strategy that may facilitate verbal output for PWA. Farias (2006) conducted research on the facilitative effects that drawing may have on word retrieval. She suggested that residual verbal abilities may be enhanced by incorporating drawing into picture naming tasks. To test this hypothesis, Farias tested 22 participants with a range of aphasia types that included anomic, Broca's, conduction, Wernicke's, and global. The participant's time post-onset varied from one month to 19 years. Twelve of the participants retained the use of their dominant hand and ten had adopted the use their non-dominant hand since their stroke. Farias (2006) assessed object naming during a baseline confrontation naming task, a drawing condition, and a writing condition. For the baseline confrontation naming task, the participant was asked "What is this?" upon presentation of the picture. Following the baseline task, stimuli were counterbalanced and put in either a drawing or writing condition. The picture was presented and then removed so that both conditions occurred under the same memory constraints. While drawing or writing, the participants were asked "What are you drawing/writing? to elicit output for naming accuracy measures. Writing was chosen as a comparison condition because it is a strategy that SLPs often encourage for PWA that, like drawing, requires graphic output. The outcome measure was accuracy of naming while drawing or writing compared to baseline and to each other.

Farias's (2006) results showed that drawing had a facilitative effect on the picture naming task *when compared to writing*, but not when compared to baseline naming.

Participants named more pictures while drawing compared to writing, and the profile of errors was different. Participants made fewer errors overall, fewer "no response" answers, and more phonologically related answers in the drawing condition compared to the writing condition. Writing had an inhibitory effect, creating more overall errors with less that were phonologically related. Farias (2006) hypothesized the facilitative effect may be because drawing accesses an object's structural, perceptual, and associative properties, thus functioning as a form of semantic cueing, much like a nonverbal form of SFA. On the other hand, writing does not function as a form of semantic cueing. The graphemes that make up a word have no relation to its semantic properties.

Farias (2006) also showed that drawing appeared to affect participants with nonfluent and fluent aphasia equally, as there was no relationship between change in number or type of errors and non-fluent or fluent aphasia classification. Additionally, Farias's research showed that drawing can be useful for PWA who use either their dominant or non-dominant hand. Overall, she found that the participants using their dominant hand did not produce higher quality drawings than the participants using their non-dominant hand. Because the drawings themselves were not used to communicate an idea but were used to improve verbal output, Farias determined that the quality of drawings was irrelevant for her experiment. The semantic-lexical network would be accessed no matter the drawing quality.

Taylor and Hough (2013) continued Farias's work by researching whether drawing could enhance word retrieval skills in a woman with chronic non-fluent aphasia. The researchers described the woman as having limited verbal output, but auditory comprehension skills that were sufficiently intact for the task. She had right hemiparesis, but was able to use writing utensils with her non-dominant hand. The participant underwent four hours of training which focused on drawing skills, including grasping a writing utensil and moving one's hand around paper. Treatment consisted of naming pictures of objects from *Classic Aphasia Therapy Stimuli (CATS)* (Fogle & Reece, 2007) and drawing answers to an SFA cueing script, as follows: The woman was shown a picture of an object and asked to name it. Regardless of her answer, she was then prompted to draw answers to the following questions: "Who uses this?" "What does this look like?" and "What does this remind you of?"

Taylor and Hough (2013) scored the participant's accuracy of naming (i.e. correct or incorrect) and the recognizability of her drawings (coded on a 5-point scale). They found that drawing the answers to the SFA questions led to an increase in the accuracy of naming for treated pictures, as well as some generalization to untreated pictures. The untreated stimuli were randomly selected from the subset of stimuli that the participant was unable to name in two out of three baseline trials. They were named in each session to provide control data. The researchers also assessed whether these increases correlated with improvements on standardized testing, specifically the *Western Aphasia Battery-Revised (WAB-R)* (Kertesz, 2006) and the *Boston Naming Test-2 (BNT-2)* (Kaplan, Goodglass, & Weintraub, 1983). The participant's Aphasia Quotient (AQ) on the *WAB-R* decreased by 6.8 points, which the researchers attributed to difficulty allocating cognitive resources to both incorporate her new strategies and maintain the skills she used successfully pre-treatment. However, the participant's *BNT-2* performance increased six points, suggesting an increase in accuracy of naming. Finally, these researchers noted improvements in drawing quality following the intervention.

Hough and Taylor (2014) replicated their first study with two men with chronic non-fluent aphasia. Both improved in their abilities to name and draw treated stimuli. Although the researchers tested effects on untreated stimuli, they reported an inability to determine effect sizes. Overall, the researchers' findings suggest that drawing may be a way to improve word retrieval. Additionally, due to the improvements in drawing quality, they suggested that even if drawing does not enhance verbal output in some participants, it still may enhance functional nonverbal communication.

The goal of both of these studies was to stimulate verbal output and determine a manner by which PWA could self-cue for word retrieval. The researchers concluded that drawing may enhance word retrieval by providing such a cue. Also, Hough and Taylor (2014) speculated about how drawing may facilitate communication. First, drawing does not rely on linguistic symbols, so it may represent a more direct route to communicate. Second, by bypassing linguistic components of expression that are typically housed in the impaired left hemisphere, drawing may provide a different neural pathway to the lexical-semantic system, assisting in the efficient retrieval of words. Drawing utilizes spatial analysis and imagery. These functions are typically housed in the right hemisphere**,** which is often intact for many PWA.

In order to test the hypothesis that nonverbal strategies may provide alternate routes for accessing the lexical-semantic system, Farias conducted a second experiment to examine the neural correlates of drawing and writing using fMRI. As opposed to physically writing a word or drawing a picture, nine healthy participants were instructed to imagine or visualize drawing and gesturing. Participants were not required to verbalize the name of the picture. fMRI showed more overall brain activation and more activation specific to the right hemisphere during the drawing condition than the writing condition. Drawing activated areas in the right hemisphere that were homologous to the areas in the left hemisphere typically activated by picture naming tasks. Farias (2006) suggested that the activation of these homologous areas while drawing may enhance word retrieval in PWA.

Summary

Verbal strategies, particularly SFA, have been used successfully to enhance word retrieval in PWA (Francis, Clark, & Humphreys, 2002). Nonverbal strategies have also been hypothesized to enhance word retrieval in both typical speakers (Krauss, Chen, & Gottesman, 2000), and PWA (Farias, 2006; Taylor & Hough, 2013; Hough & Taylor, 2014). Nonverbal strategies have also been combined with verbal strategies (e.g. drawing answers to SFA questions) and have shown promising results (Taylor & Hough, 2013). All of these strategies are thought to work by functioning as a form of self-cueing and activating semantic networks in the brain. However, the research to support this hypothesis in nonverbal strategies is limited. Drawing has shown slight facilitative effects on naming, but not when compared to control tasks (Farias, 2006). Additionally, it is not yet known what type of candidate might benefit most from this type of strategy.

In the current study, we aimed to examine the effects of two nonverbal word retrieval strategies, drawing and gesturing, relative to waiting (i.e. the control condition) on a picture naming task. Both nouns and verbs were to be included to determine the effects on both parts of speech. Most previous naming experiments have primarily examined nouns. We hypothesized that drawing and gesturing would both be facilitative when compared to the wait (i.e. control) condition based on similar results in previous literature (Boo & Rose, 2011; Taylor & Hough, 2013; Hough & Taylor, 2014). We also hypothesized that drawing would be more facilitative for nouns, while gesturing would be more facilitative for verbs. This hypothesis was based primarily on real life experience, where it is much easier and/or faster to gesture verbs, such as “throw” than to draw the action.

Methods

This research study was approved by the University of Iowa Institutional Review Board. The participant was deemed competent to consent and was paid 10 dollars per hour for his participation.

Participant Characteristics

The following inclusionary and exclusionary criteria were used to select the participant: native English speaker with no prior history of significant language, learning, psychiatric or neurological disorders; vision and hearing that were sufficient to carry out the task; relatively intact auditory comprehension skills in order to ensure that he/she could follow experiment instructions; and a diagnosis of aphasia for greater than six months, so that he/she was in the chronic stage of recovery. Being in the chronic stage of recovery helped to rule out any changes due to spontaneous recovery. Additionally, when aphasia persists into the chronic stage, word retrieval deficits, the impairment to be researched, often remain (Goodglass & Wingfield, 1997). Following Farias (2006), the potential participant could have the use of either his/her dominant or non-dominant hand for the purposes of gesturing and drawing. The selected participant was recruited from the participant database at the Wendell Johnson Speech and Hearing Clinic (WJSHC). He was a twenty-four year old male who was three years and four months post-onset of an aneurysm and subsequent subarachnoid hemorrhage. Before the aneurysm, he was right-hand dominant but currently uses his left hand.

Standardized Testing

The participant was tested using the *WAB-R* (Kertesz, 2006) four days prior to baseline testing. He was tested in the areas of spontaneous speech, auditory verbal comprehension, repetition, and naming and word finding. He was also given the *Apraxia Battery for Adults- Second Edition (ABA- 2,* Dabul, 2000), completing the following subtests: Diadochokinetic Rate, Increased Word Length A and B, Limb Apraxia, and Oral Apraxia. Outcomes of these tests will be discussed in the Results section.

Stimuli

For baseline testing, black and white line drawings representing 83 nouns and 94 verbs were selected from *An Object and Action Naming Battery* (*OANB*, Druks & Masterson, 2000). Pictures were removed from the full set of pictures for the following reasons: British target words (e.g. “pram” for American English “stroller”); ambiguous pictures (e.g. bending); and any target words longer than one syllable (e.g. juggle), in order to standardize length. Words that appeared in both the noun and verb sets (e.g. “tie”) were only included in one set, either nouns or verbs.

A subset of the items that the participant was unable to name in baseline testing was selected for the experiment. These items were initially divided into three sets of 14-15 pictures each. The sets were matched on word length (in number of phonemes) and frequency of occurrence (Francis & Kucera, 1982, as cited in Druks & Masterson, 2000). Each set was used in a different condition (drawing, gesture, wait) for the first experimental session. For the next session, stimuli from each condition were randomly split and assigned to the conditions in which they had not yet been named. For example, the words that were initially drawn were randomly split between the gesture and wait conditions. Then for session 3, words that had first been drawn and then gestured were put in the wait condition, along with the set that had first been gestured and then drawn. In each session, the sets were not significantly different in word length or frequency (all p-values > .20). See Table B1 for the distribution of stimuli across conditions and sessions.

Procedure

All task procedures were conducted by a research assistant, a first year graduate student in the Communication Sciences and Disorders program, and myself, a second year graduate student in same program. Please see Table B2 for a visual representation of the experiment schedule.

Baseline Naming

In the first two sessions, 83 nouns (Session 1) and 94 verbs (Session 2) from the *OANB* (Druks & Masterson, 2000) were administered for naming. The pictures were presented via E-Prime Psychology Software (Schneider, Eschman, & Zuccolotto, 2002). A fixation point slide was presented before each picture, and the participant was told to indicate for the examiner to advance to the picture when he was ready. The participant was instructed that he could take a break at any fixation slide. Following the fixation slide, a picture was presented for 30 seconds and the participant was asked to name it.

The researchers coded accuracy during naming tasks using the first complete naming attempt (Roach et al., 1996). Online coding was done by the experimenter, using the Enter key for correct, the Space bar for incorrect, and no key pressed if no response was verbalized. For all online coding tasks, the keyboard was held out of the sight of the participant so that he did not receive online feedback. Offline coding was done by watching the videotape of the session. Final coding judgments were made by incorporating information from both online and offline coding. In the final experiment, the noun stimuli were not used, but the results and a comparison to baseline verb stimuli will be discussed later.

Training

In the following two sessions, the participant was trained to use gesture and drawing in the context of naming both nouns and verbs. The training sessions were determined to be necessary because, while gesture may be fairly natural while speaking, drawing is not. Results may have been skewed if one task was significantly easier than the other. The researchers wanted to equalize the difficulty of the tasks as much as possible. Additionally, a related prior study included multiple training sessions that incorporated elements such as correctly holding the writing utensil, moving one's hand around the paper, and tracing, copying, and drawing pictures of objects (Taylor & Hough, 2013). Both training sessions were conducted by the research assistant and myself. Each training session (drawing, gesturing) took about 60 minutes, with equal time allotted to training nouns and verbs within each session. Both trainings took place in quiet therapy room with comfortable chairs and ample room for movement.

For the drawing training, the participant was asked to complete the following tasks: grouping items by semantic category and shape; copying shapes; and identifying details that are missing from a drawing. To address drawing verbs, the researchers acted out various scenes with one action (e.g. dropping papers). The participant was asked to draw the actions and then received feedback on possible improvements, specifically highlighting important details of objects, or showing the direction of motion of verbs.

The gesture training session was based on principles of Visual Action Therapy (Helm-Estabrooks, Fitzpatrick, & Barresi, 1982). For verbs, the participant matched clinician gestures to pictures of gestures, produced the gesture with the picture of the gesture as a prompt, and produced the gesture with the involved object as a prompt. For nouns, the participant matched clinician gestures to pictures of objects, produced gestures with a picture of the gesture visible, and produced gestures with the object prompt.

Experimental Naming Tasks

The planned protocol for the experimental sessions was as follows: The participant would undergo six sessions of experimental naming, three each for both nouns and verbs. Naming would be assessed in three different conditions in each session: gesture, drawing, and wait (i.e. control). This would ensure that the participant would name the 45 nouns and 45 verbs in each of three experimental conditions: Drawing, gesturing, and wait. The conditions were to be presented randomly across trials (e.g. draw, draw, gesture, draw, wait, gesture, etc.).

Due to time constraints, we altered the proposed protocol. It became necessary to choose either nouns or verbs for the experiment, as there was not sufficient time to treat both. During the first noun session, the participant frequently began to gesture or draw with his finger before the actual condition was presented. Thus, two conditions were utilized for some of the pictures, compromising the reliability of that data. Also, the participant displayed difficulty switching between conditions due to their random presentation. We elected to modify the experiment slightly and begin the experiment again using just the verb stimuli. We grouped all pictures within each condition together and clarified the verbal directions as a way to lead to greater understanding of and compliance with instructions. The order of grouped conditions was altered for each experimental session to reduce order effects: Session 1 (Draw, Gesture, Wait); Session 2 (Gesture, Wait, Draw); Session 3 (Wait, Gesture, Draw).

The instructions for each of the conditions were as follows: For the wait time condition, the participant was asked to put his hands on the table in front of him in order to ensure that no strategy was used. However, because this participant displayed paresis of his right side, he was more comfortable folding his hands together in his lap rather than placing both hands flat on the table. For the drawing condition, the participant was provided with a piece of paper and a pen. For all conditions, the participant was asked to remain still until the instructions for the condition were provided. Instructions for each experimental condition were presented both visually on the computer and verbally. When the instruction slide appeared on the screen, the clinician also verbalized a short instructional phrase: “Keep thinking” for the wait condition; “Gesture” or, if the participant displayed confusion, “Use your hands” for the gesture condition; and “Draw”, usually paired with a point to the paper for the drawing condition. Verbal reminders for compliance with instructions were provided as needed.

Procedures for the experimental sessions were similar to the baseline naming session, with two additions. After the participant attempted to name a picture once (i.e. pre-condition), he performed a specified condition, and was then asked to name the same picture again (i.e. post-condition). Prior to beginning the session, the participant was reminded that the pictures were verbs. This was to prevent confusion, as a picture of a person riding a bicycle could be labeled both with the noun “bike” or the verb “ride”. If the participant named the picture correctly pre-condition, we pressed any keyboard key to advance to the next picture. If the participant did not name the picture, the experiment automatically advanced to the instructions for the condition after 30 seconds. If the participant named the picture incorrectly, the experimenter pressed the space bar to advance to the slide showing instructions for the condition. The key pushed or the fact that no key was pushed was recorded by E-Prime Psychology Software (Schneider, Eschman, & Zuccolotto, 2002) to track accuracy. For quantitative analysis, these original codes became 2 for correct, 0 for no verb/noun verbalized, and -1 for an incorrect answer. These numerical values, seen in Figure C1, allowed us to quantify changes made throughout the experiment.

Table B3 depicts the stimuli presentation process. Thirty seconds were allotted for each condition, but the participant did not always perform the condition for the full time allotment. After the 30 seconds had passed, another fixation slide was presented and the clinician said “Here is the picture”, to cue the participant that the same picture was about to be presented again (i.e. post-condition). The verbal cue was particularly important in the drawing condition, during which the participant was looking down at his paper. Without the auditory cue, he may have missed the picture being presented again.

Debriefing

The final session included debriefing questions. These questions were asked to assist in drawing conclusions about the usefulness of these strategies for participants with particular characteristics. The questions as follows:

1) Have you been exposed to or had experience with sign language? If so, please describe.
2) Do you have any experience or training in art? Do you consider yourself an artist and/or is art one of your hobbies?
3) Do you purposely use gesturing to communicate words that you have difficulty saying?
4) Do you purposely use drawing to communicate words that you have difficulty saying?

Analysis

Facilitative effects were determined by the condition with the greatest index of change. The index of change was a numerical representation of naming accuracy pre-condition to post-condition for pictures which had the potential for improvement (i.e. pre-condition coding incorrect or no verb verbalized).

Results

Standardized Testing

The participant achieved an Aphasia Quotient (AQ) of 53 (moderate severity) on the *WAB-R* (Kertesz, 2006). His profile of relative strengths in receptive tasks compared to relative weaknesses in expressive tasks is shown in Table B4 and suggested Broca's Aphasia. When experiencing anomia during testing, the participant verbalized several automatized phrases (e.g. "Oh my God", "Oh, damn"). He wrote words or letters and drew frequently, particularly when he was unable to answer questions verbally. The participant demonstrated relatively intact auditory comprehension skills even when he did not have the expressive language necessary to answer the question (i.e. He drew two animals of differing sizes when asked "Is a horse larger than a dog?").

The participant's results on the *ABA-2* are depicted in Table B5. He demonstrated a severe impairment in the second subset of increasing word length. However, it was determined that this would have a minimal effect on the current experiment because all of the target words chosen were one or two syllables (e.g. sing*ing*). The participant's impairments were most evident at the third step of increasing word length, at which target words were more than two syllables.

Reliability

Reliability was assessed for the accuracy coding of baseline nouns, baseline verbs, and the three experimental sessions. Video recorded sessions were reviewed to gather offline coding data. Due to errors in videotaping, not all targets had video confirmation. See Table B6 for reliability data. Intrarater reliability was assessed by comparing the online and offline coding of accuracy by me in each session except for baseline verbs. The research assistant did the online coding for that session. Intrarater reliability was consistently higher than 87%. Interrater reliability was assessed by comparing the offline responses of the research assistant and myself. This was consistently higher than 87%.

We determined a final response of correct, incorrect, or no verb verbalized based on both the online and offline coding. The majority of disagreements between these were due to mistakes in online coding or disagreements regarding acceptable synonyms based on the picture (e.g. “boxers” for shorts was considered correct, “waiting” for fishing was considered incorrect).

Baseline Naming: Nouns

The participant attempted to name 83 nouns. Baseline accuracy results are summarized in Figure C2. The results show that the participant achieved roughly equal correct and incorrect results, with less nouns coded as no noun verbalized. This suggests that the participant was motivated to attempt the task and also that he was unlikely to verbalize a verb or other part of speech for a noun. The subset for further testing was selected from the 58 nouns for which the participant produced either an incorrect response or no response.

Baseline Naming: Verbs

Although 94 verbs were initially included in the baseline naming task, three pictures were inadvertently missed due to errors of administration. The subset for the experiment was selected from the 68 verbs that were coded either incorrect or no verb verbalized. Figure C2 shows the breakdown of baseline coding. Contrary to baseline nouns, the participant’s primary response was no verb verbalized, then correct. This increased amount of no verb verbalized responses, compared to baseline nouns, suggested that the task lent itself to verbalizing nouns, not verbs.

Experimental Naming

Table B7 shows data for total number of pictures included per session, per condition, the breakdown of coding, and the improvements made post-condition. The first line of Table B7 shows the total amount correct pre-condition (i.e. total number of opportunities was either 44 or 45). The following lines show the categories of responses calculated from the subset that was coded either incorrect or no verb verbalized in the pre-condition (i.e. stimuli that was attempted again following the condition). Data was analyzed using Microsoft Excel (Microsoft, 2010) and is depicted in Figures C3, C4, and C5.

An index of change was developed to quantify degree of change between a correct response, no verb verbalized, and an incorrect response. As illustrated in Figure C1, correct responses were coded as 2, no verb verbalized as 0, and an incorrect response as -1. Positive indices of change thus indicated improvement. A change from an incorrect response to no verb verbalized was considered an improvement. It is important to note that no verb verbalized did not mean that the participant did not verbalize anything. Table B8 shows that for 64% of answers coded as no verb verbalized, the participant verbalized nouns. Verbalizing relevant nouns was considered similar to circumlocution or SFA, and thus more useful than verbalizing an incorrect verb, on which the participant frequently perseverated.

Analysis was then performed on the index of change for each individual condition. This data can be seen in Figure C6. Average index of change was determined by dividing the sum of the changes by the total number of targets that had the potential for change (i.e. targets originally coded either no verb verbalized or incorrect). Overall, the gesturing condition created the largest index of change (i.e. .448) and then waiting (i.e. .433). Drawing had the smallest index of change (i.e. .308). However, the differences between the conditions were not significant (i.e. drawing vs. wait, p = .529; gesture vs. wait, p = .747; drawing vs. gesture, p = .668).The gesture and drawing conditions were also combined into the overall category of facilitated conditions and compared to the unfacilitated wait condition. The wait condition showed an index of change of .433, while the two facilitated conditions combined had an index of change of .382. A two-tailed t-test between these conditions showed a p-value of .796, indicating that the difference was not significant.

Figures C7 and C8 both depict indices of change. In Figure C7, indices of change are grouped by condition, and in Figure C8, they are grouped by session. As can be seen in Figure C7, the facilitative effects of all the conditions together decreased as the sessions progressed. Possible reasons for this will be discussed in the next section. However, the pattern of facilitative effects varied by condition. The facilitative effects of the wait condition decreased across as the experiment progressed. The facilitative effects of drawing dropped between Sessions 1 and 2 but then rose again in Session 3. Gesture was the only condition for which the first session was not the most facilitative. The facilitative effects became much higher in the second session and then dropped again in the third. However, the third session was still more facilitative than the first. Gesture was the only condition to show this pattern.

Figure C8 shows the variability of the facilitative nature of each condition within the same session and possible order effects across sessions. Session 3 had the most consistency across conditions, while Sessions 1 and 2 were more variable. Session 3 was also the only session in which the first condition tested was the most facilitative. Session 1 and 2 show that the participant was most successful with later occurring conditions. Implications for this finding are discussed later. Figure C8 also shows that the order in which the conditions were presented in each session did not have an effect on indices of change. There is no evidence of a correlation between, for example, the conditions that occurred first being the most facilitative.

Debriefing Questions

The results of the debriefing questions are as follows:

1) When the participant was younger, he had a Deaf friend who would sign around him. The participant knew a handful of signs.
2) The participant participated in art classes in elementary school, but has not had any other formal art experience since then. He considers himself an artist only in that he enjoys drawing, but does not consider himself to be a professional artist. Art is not one of his hobbies.
3) The participant indicated that he often uses gesture to communicate basic wants and needs like hunger or thirst.
4) The participant indicated that he does draw and gave the example of drawing various kinds of cereal to indicate the kind he wanted.

Discussion

The motivation for the current study was to further the available research on whether drawing is a viable means for PWA to cue themselves in order to enhance verbal output. Although results in this study did not show significant improvements in verbal output compared to a control condition, drawing has several other benefits for PWA. Even if, after drawing, the PWA is still unable to retrieve the target word, it is possible that his functional communication may be enhanced due to the additional cues he is giving his partner.

The insignificance of results compared across conditions shows that all of the conditions were facilitative. This may suggest an effective quality common to all conditions. The only similarity across all conditions was the 30 seconds of time provided between pre-condition and post-condition naming. However, it is important to consider that the scoring system was biased towards showing facilitative effects. Because pictures that were correct pre-condition were not named a second time, there was not an opportunity to show declining performance following the conditions.

The finding that the conditions as a whole became less facilitative as the experiment progressed can be attributed to several possibilities. First, the same pictures were named in each session. The participant may have been bored with the repetitive stimuli and thus less engaged in performing the conditions. Additionally, the participant's motivation could have decreased as he became familiar with the pictures he consistently had difficulty naming. However, this overall finding differed from the results within each individual session. Within each session, it was found that later occurring conditions were generally more facilitative than the first condition. This suggests that, despite training and examples, the participant required increased time in each session to refamiliarize himself with task demands. Taylor and Hough (2013) described an applicable hypothesis for this behavior. They believed their participant may have had difficulty allocating cognitive resources to synthesize her pre-experiment skills with the newly targeted skills from the experiment. The same hypothesis was suggested by Frick-Horbury & Guttentag (1998) and can also be suggested here.

Multiple participant characteristics may have affected the lack of facilitative effects seen in this study. For example, as discussed earlier and shown in Table B5, standardized testing showed that the participant had moderate limb apraxia and mild oral apraxia. He had severely impaired performance on a subtest addressing repetition of words with increasing length. It is possible that gestures were less facilitative than they might otherwise be due to concomitant limb apraxia. Additionally, although no groping behaviors were observed, it is possible that the participant had instances of retrieving the target word, but being unable to verbalize it. Had this happened, the facilitative effects would have appeared less than they might otherwise be.

Limitations and Future Directions

Elements of CILT do need to be considered when interpreting this experiment. In CILT, PWA are not allowed to utilize compensatory strategies, including drawing and gesturing (Cherney et al., 2008). During this experiment, the participant would occasionally attempt to gesture when that was not the specified condition. In order to ensure more experimental control, we did not want multiple conditions to be completed at one time. Thus, the participant was reminded not to gesture during the draw or wait conditions. Research has suggested that gesture suppression creates negative effects of speakers, including inhibiting word retrieval, thus increasing hesitations and tip-of-the-tongue experiences, and decreasing fluency and intonation (Frick-Horbury & Guttentag, 1998). Unfortunately, data was not collected on how often the participant gestured during the baseline tasks. Knowing this information would help us draw a conclusion about the impact of restricting gestures in 66% of trials (i.e. drawing and wait conditions)

The training sessions were determined to be necessary based on examples set by previous research (Taylor & Hough, 2013) and the idea that gesturing and drawing are not equal in difficulty. However, the fact that gesturing took more sessions to reach its maximum facilitative effects suggests that gesturing may not be as intuitive as originally thought. Although it is believed that the training sessions were helpful in this context, no assessment of learning was completed. Future studies should consider the use of a criterion of performance on training tasks to ensure that presumed task abilities are met.

A time limit was included to help standardize the participant's performance on all stimuli, instead of spending a great deal of time on pictures at the beginning of the session and less on pictures at the end as he fatigued or became bored. However, the participant demonstrated strong motivation to continue naming even after the time limit had passed. The participant was allowed to continue attempting to name until he verbalized that he was ready to move to the next picture, in an attempt to limit frustration. No data was collected on verbalizations made after the time limit was up. However, the participant often continued performing the condition, circumlocuting, and verbalizing the target after the time limit. The participant had a positive attitude and displayed minimal frustration, but it was evident that he would have appreciated more time, particularly for the drawing condition. The presence and length of a time limit should be individualized to each participant and his/her characteristics such as persistence and frustration, as seen in baseline tasks.

Although we attempted to limit the participant's actions to only the specified condition, this was not always possible. Gesture is natural in speech, so the participant occasionally inadvertently gestured while waiting for the condition to be presented. Additionally, even when the paper and pen were not available, the participant occasionally performed the gesture condition by "writing" the word in the air. Thus, sometimes a combination of conditions was used. Verbal and gestural reminders were used to cue the participant to keep his hands on the table and/or perform only the specified condition when this occurred. Future studies may consider a more intentional condition, such as the writing condition used in Farias's experiment (2006), to limit inadvertent performance of a more natural condition, such as gesture. A less natural condition, more similar to drawing or writing, may equalize the task demands more than in the current experiment.

The research assistant and I occasionally disagreed regarding the participant's first complete naming attempt. The criteria for first complete naming attempt specified that it had to be the correct part of speech. At times, the participant's first complete naming attempt could have been considered a noun or a verb, so it was up to the researchers to determine what the participant intended based on context. For example, for the word "rocking", the participant verbalized both "swing" and "sleeping". I counted "swing" as a verb, because there was no swing in the picture that the participant may have been naming. However, the research assistant determined swing was a noun and scored the next true verb the participant said, "sleeping". Another potential error related to first complete naming attempt was related to the participant's dialect. In his dialect, final consonant deletion is common. Due to this, the researchers may have been unsure of whether the participant had said a complete naming attempt or a fragment of a word, which would not have been counted as a complete naming attempt. However, reliability was consistently greater than 87%, which indicates that any such disagreements had a minimal effect on coding.

Order effects must be considered when assessing results of this experiment. Initially, the order of the conditions was going to be randomized. However, following the first noun session, it was determined that, although this method would help factor out order effects, it was not practical. The participant often became confused as to what condition he was supposed to do. Additionally, because the paper and pen were readily available, the participant attempted to draw when that was not the specified condition. When it was determined that, due to time constraints, either nouns or verbs would have to be chosen, the methodology was changed for the three experimental verb sessions. Conditions were grouped so that the participant completed all of one condition before moving to the next condition. Order of conditions was different for each session to balance out any potential order effects. As can be seen in Figure C8, there is no pattern to which order within each session was most or least facilitative.

Although this experiment did not show significant effects of conditions tested and did not assess generalization, future studies will need to carefully consider this topic. Provided that drawing works in a similar manner as SFA by accessing semantic networks, generalization could be expected with related stimuli. Stimuli need to be carefully selected to ensure that data is gathered for both related and unrelated control stimuli in order to make conclusions about generalization.

Although in this experiment we found roughly equal results of drawing and gesturing (i.e. neither was facilitative), we have to consider that the tasks may not have been equal in difficulty or status. As stated, various research has suggested that gesturing and speaking are so highly related that they originate from one conceptualizer in the brain. If this is the case, drawing and gesture are not equal strategies and care must be taken in comparing the two. On the contrary, even if gesturing is integrally linked with speech, more so than drawing, this experiment brought gesturing to a more conscious level. This may have changed the way it was conceptualized in the brain.

Picture naming tasks lend themselves to verbalization of nouns, not verbs. In this experiment, the participant required multiple prompts that the object of the task was to say what the subjects of the pictures were *doing*. Despite prompts, he frequently verbalized nouns instead. Requiring verbs in response to a picture stimulus may have created a higher number of responses coded no verb verbalized than would have occurred if nouns were targeted. Because the task lent itself towards verbalizing nouns, it likely required more cognitive resources to verbalize verbs. We hypothesize that we would have found greater facilitative effects had we also tested nouns due to decreased need for cognitive resources and more natural task requirements.

Appendix A: Training Protocols

Drawing Training

Nouns

1) Grouping things by semantic categories, color, and shape
    a. Semantic Categories: Transportation, food, sports
    b. Shape: Circular things (ball, orange, etc.) vs. square things (picture frame, TV, etc.)
   - Give feedback about important details to consider
   - May shape behavior by providing the categories, etc.

2) Copying shapes: Screens for co-occurring limb apraxia
   - Be prepared to take step back to tracing if he is showing difficulty copying

3) Identify details that are missing from a drawing and add them
   - Draw attention to important details

   a. Provide examples with modeling and verbal coaching
   b. Show half-completed drawing and say “This is an elephant. What needs to be added?”
      i. Mug without handle
      ii. House without door
      iii. Elephant without trunk
      iv. Door without a knob
      v. Cat without ears
      vi. Flower without petals
      vii. Hand without thumb
      viii. Car without a wheel
      ix. Dog without a tail
      x. Chair without a leg

4) Show picture, have participant draw version of the given picture on the provided shape
    a. Circle:
       i. Pizza
       ii. Clock
       iii. Cat
       iv. Flower
    b. Square:
       v. Present
       vi. Dice
       vii. Envelope
       viii. Old TV

Verbs

1) One clinician acts out various scenes, second clinician provides verbal feedback and models important details to include
   - Builds on the important details considered in the CDP
   - Arrow, highlighting or making important details bigger, including details that make a distinction, etc.
     a. Clinician drops papers
        - May include arrow from hands to ground
     b. Clinician brushes teeth
        - May make toothbrush big to show what it is
     c. Clinician puts on hat
     d. Clinician lifts something
        - May include arrows from ground up
     e. Clinician uses binoculars (looking)
     f. Clinician locks door

Gesture Training: Based loosely on Visual Action Therapy
Imitation of gestures: Screens for limb apraxia

- Thumbs up
- Time-out

<u>Verbs:</u>
Recognition:

1) Matching clinician gesture to **picture of gesture**
    a. Clinician drops papers
    b. Clinician brushes teeth
    c. Clinician puts on hat
    d. Clinician lifts weights
    e. Clinician uses binoculars
    f. Clinician locks door
    g. Clinician shooting a basketball
    h. Clinician hula-hooping
    i. Clinician licking an envelope
    j. Clinician putting on deodorant

Production:

2) Produce it with the picture visible
3) Produce it with just the object prompt

<u>Nouns:</u>
Recognition:

1) Matching clinician gestures to **pictures of objects**
    a. Clinician pretends to peel- banana
    b. Clinician pretends to hammer- hammer
    c. Clinician pretends to shuffle and deal- cards
    d. Clinician pretends to wash hair- shampoo
    e. Clinician pretends to butter bread- knife
    f. Clinician pretends to watch TV- remote
    g. Clinician licking an ice cream cone- ice cream cone
    h. Clinician coloring- crayons
    i. Clinician cutting a piece of paper- scissors
    j. Clinician flossing teeth- floss

Production:

1) Produce it with the picture of action visible
2) Produce it with just the object visible

Appendix B: Tables

Table B1: Distribution of Stimuli Across Conditions and Sessions

Draw- Session 1	Draw- Session 2	Draw- Session 3
Blowing	Weaving	Washing
Catching	Dropping	Jumping
Crawling	Lighting	Peeling
Folding	Melting	Touching
Leaning	Painting	Biting
Licking	Raking	Cutting
Marching	Roaring	Knitting
Pushing	Bleeding	Fishing
Shaving	Floating	Rocking
Sinking	Pouring	Dancing
Sliding	Pulling	Flying
Smoking	Sailing	Ringing
Sneezing	Smiling	Skipping
Waving	Swimming	Shooting
		Bouncing

Gesture- Session 1	Gesture- Session 2	Gesture- Session 3
Fishing	Biting	Marching
Rocking	Cutting	Folding
Dancing	Jumping	Crawling
Weaving	Knitting	Shaving
Ringing	Touching	Blowing
Bouncing	Washing	Catching
Painting	Peeling	Waving
Skipping	Pushing	Bleeding
Flying	Sinking	Sailing
Dropping	Sliding	Smiling
Raking	Smoking	Pulling
Melting	Sneezing	Swimming
Lighting	Leaning	Pouring
Shooting	Licking	Floating
Roaring		

Table B1- continued

Wait- Session 1	**Wait- Session 2**	**Wait- Session 3**
Smiling	Ringing	Smoking
Bleeding	Rocking	Sneezing
Washing	Shooting	Sliding
Pulling	Skipping	Leaning
Biting	Dancing	Pushing
Peeling	Fishing	Licking
Touching	Flying	Sinking
Floating	Bouncing	Painting
Cutting	Blowing	Dropping
Pouring	Catching	Melting
Knitting	Crawling	Lighting
Jumping	Folding	Weaving
Swimming	Marching	Roaring
Sailing	Shaving	Raking
	Waving	

Table B2: Experiment Schedule

Session 1	WAB, case history, consent
Session 2	Baseline Nouns
Session 3	Baseline Verbs
Session 4	Drawing Training: Nouns and Verbs
Session 5	Gesture Training: Nouns and Verbs
Session 6	Nouns Session 1
Session 7	Verbs Session 1
Session 8	Verbs Session 2
Session 9	Verbs Session 3, apraxia testing, screening questions

Table B3: Stimuli Presentation

Individual Stimuli Presentation	Time
View Picture/Attempt to Name	30 seconds
If Incorrect or No Response Given:	
Perform Experimental Condition	30 seconds
Picture Re-presented/Attempt to Name	30 seconds
If Correct:	
Fixation Slide	Unlimited, participant indicates readiness for next picture

Table B4: Participant Profile from *Western Aphasia Battery- Revised (WAB-R)*

Components of the Aphasia Quotient	Score
Spontaneous Speech	11/20
Information Content	7/10
Fluency, Grammatical Competence, Paraphasias	4/10
Auditory Verbal Comprehension	6.6/10
Repetition	4.8/10
Naming and Word Finding	4.1/10

Table B5: Results of *Apraxia Battery for Adults- Second Edition (AB*A- 2)

ABA Subtest	Impairment Level
Diadochokinetic Rate	Mild
Increasing Word Length A	Mild
Increasing Word Length B	Severe
Limb Apraxia	Moderate
Oral Apraxia	Mild

Table B6: Intrarater and Interrater Reliability

Session	Number of Targets Included in Analysis	Intrarater	Interrater
Baseline Nouns	75/83 (90%)	65/75 (87%)	75/75 (100%)
Baseline Verbs	91/91 (100%)	79/91 (87%)	90/91 (99%)
Verbs Session 1 (pre)	36/43 (84%)	35/36 (97%)	36/36 (100%)
Verbs Session 1 (post)	20/27 (74%)	19/20 (95%)	19/20 (95%)
Verbs Session 2 (pre)	34/43 (79%)	32/34 (94%)	32/34 (94%)
Verbs Session 2 (post)	23/23 (100%)	22/23 (96%)	20/23 (87%)
Verbs Session 3 (pre)	42/43 (98%)	42/42 (100%)	39/42 (93%)
Verbs Session 3 (post)	26/29 (90%)	26/26 (100%)	26/26 (100%)

When less than 100% of targets were included in video analysis, it was due to a lack of video confirmation.

Table B7: Breakdown of Responses Before and After each Condition

	Session 1		Session 2		Session 3	
	Pre-Condition	Post-Condition	Pre-Condition	Post-Condition	Pre-Condition	Post-Condition
Drawing						
Correct (pre)	9/14 (67%)	NA	2/14 (14%)	NA	6/15 (40%)	NA
Correct (post)	NA	1 (20%)	NA	0 (0%)	NA	1 (11%)
Incorrect	2 (40%)	1 (20%)	2 (17%)	1 (8%)	2 (22%)	0 (0%)
No Verb Verbalized (NVV)	3 (60%)	3 (60%)	10 (83%)	11 (92%)	7 (78%)	8 (89%)
Total	5	5	12	12	9	9
Gesture						
Correct (pre)	5/15 (33%)	NA	5/14 (36%)	NA	3/14 (21%)	NA
Correct (post)	NA	0 (0%)	NA	4 (44%)	NA	1 (9%)
Incorrect	4 (40%)	2 (22%)	4 (44%)	3 (33%)	2 (18%)	1 (9%)
NVV	6 (60%)	7 (78%)	5 (56%)	2 (22%)	9 (82%)	9 (82%)
Total	10	9**	9	9	11	11
Waiting						
Correct (pre)	2/14 (14%)	NA	6/15 (40%)	NA	5/14 (36%)	NA
Correct (post)	NA	4 (33%)	NA	1 (11%)	NA	0 (0%)
Incorrect	3 (25%)	2 (17%)	5 (56%)	5 (56%)	2 (22%)	0 (0%)
NVV	9 (75%)	6 (50%)	4 (44%)	3 (33%)	7 (78%)	9 (100%)
Total	12	12	9	9	9	9

**The reason for the number mismatch between pre- and post- conditions was due to one target that received an online code of incorrect, so there is no post-condition data. However, its final code (i.e. counted in column 1) was correct.

If the participant named a picture correct pre-condition, it was not represented. This is why there are no post-condition correct data.

Table B8: Breakdown of No Verb Verbalized Codes in Verbs Session 2

	Pre-Condition	Post-Condition
Verbalized Noun	9 (64%)	5 (50%)
Verbalized Nothing or Non-Specific Phrases (e.g. “like um”, “damn”)	4 (29%)	3 (30%)
Other*	1 (7%)	2 (20%)
Total	14	10

*The other coding refers to the participant’s use of automatized phrases (e.g. “See you later!”), songs, perseverations, or adjectives.
The total numbers in this table do not necessarily match the numbers in Table 5, as some responses were unable to be confirmed via video recording.

Appendix C: Figures

Figure C1: Error Coding

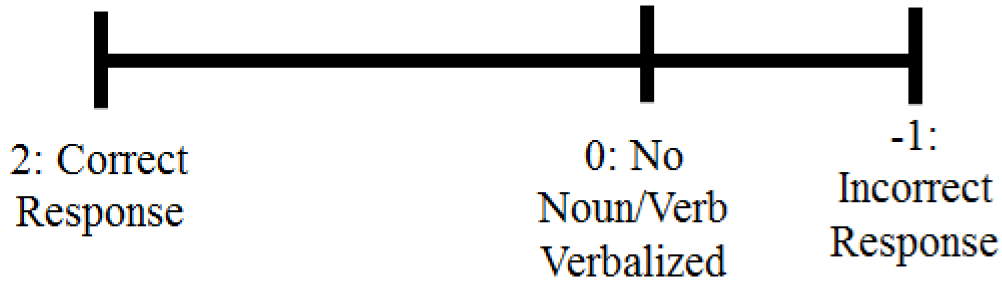


Figure C2: Breakdown of Responses, Baseline

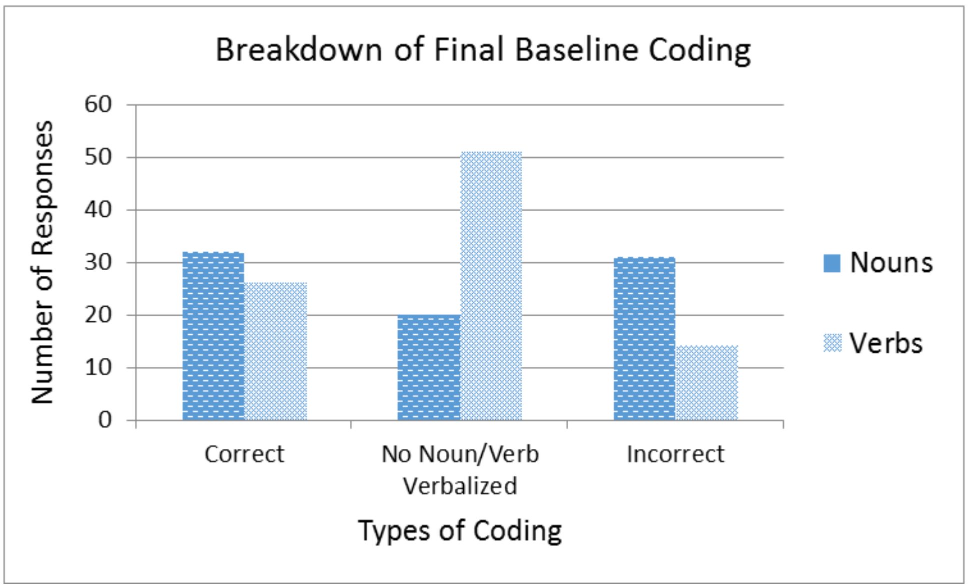


Figure C3: Breakdown of Responses, Drawing Condition

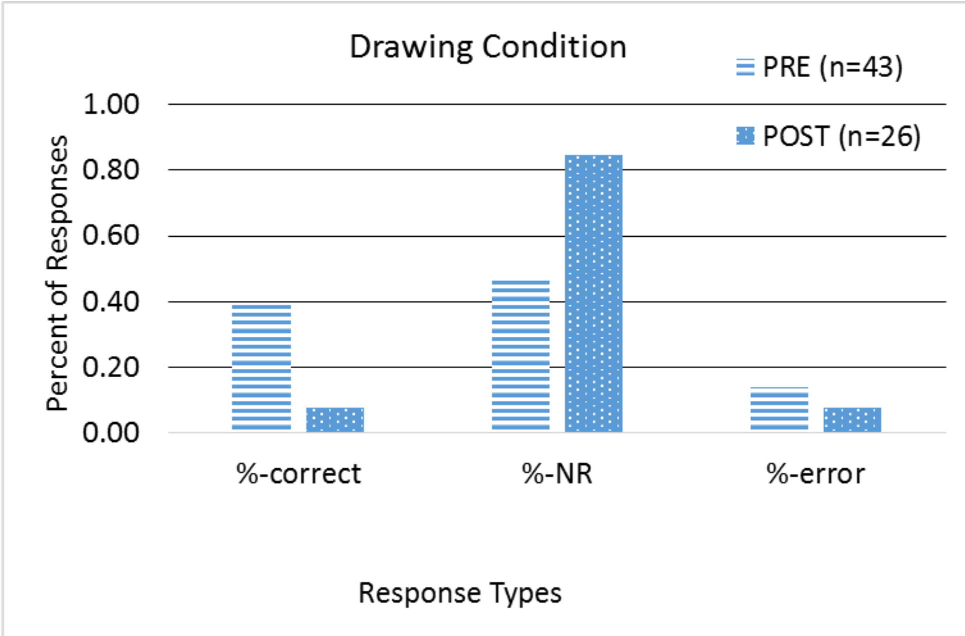


Figure C4: Breakdown of Responses, Gesture Condition

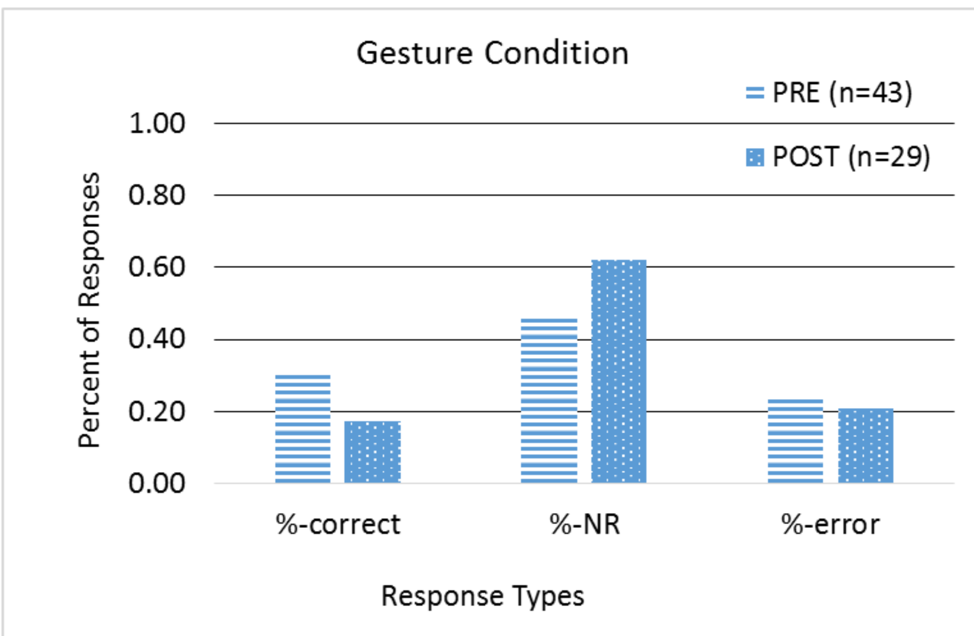


Figure C5: Breakdown of Respones, Wait (Unfacilitated) Condition

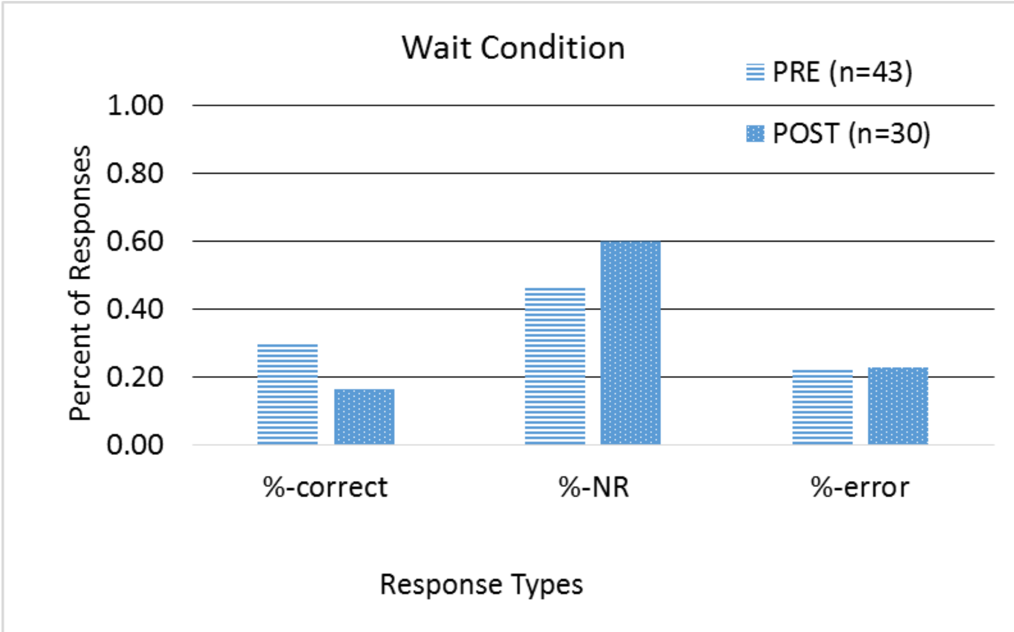


Figure C6: Average Change by Condition

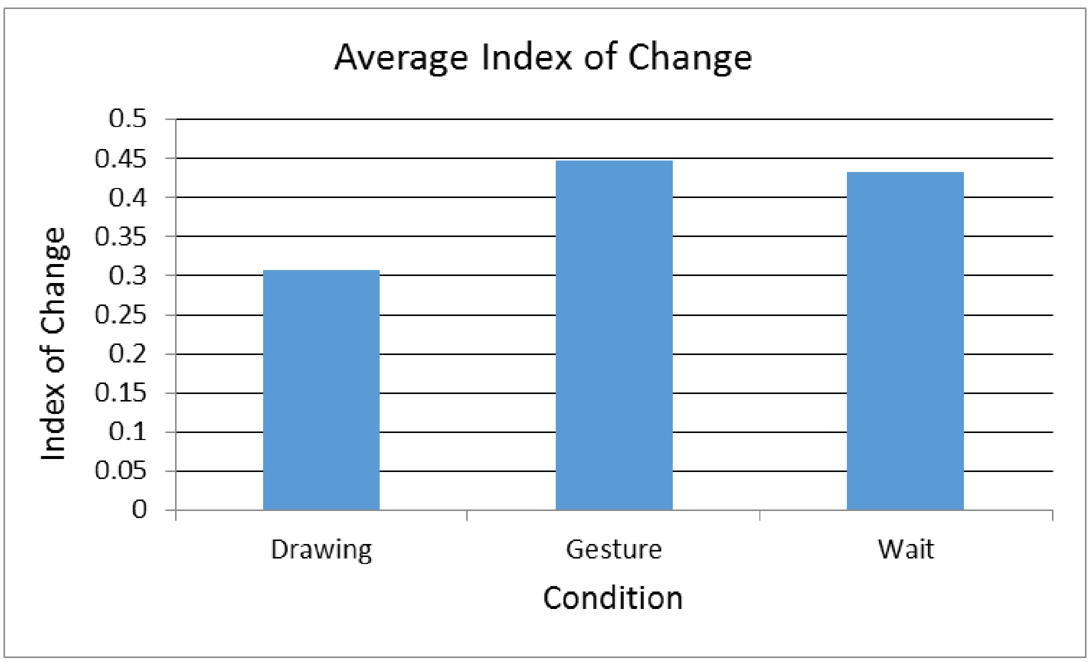


Figure C7: Index of Change By Condition

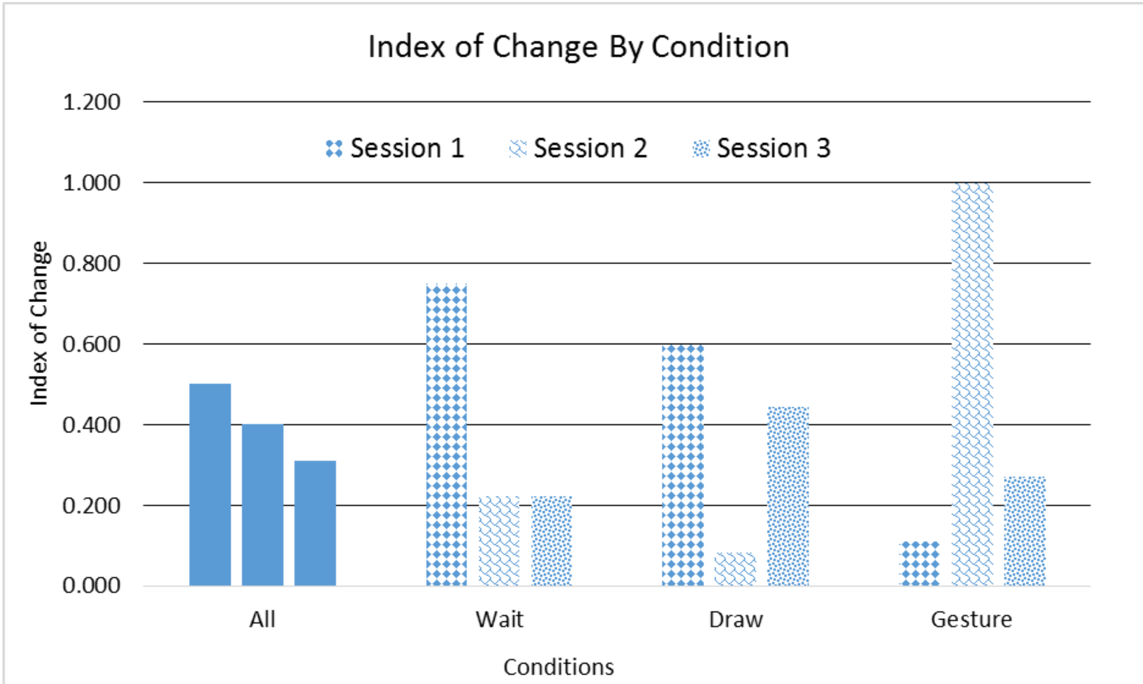
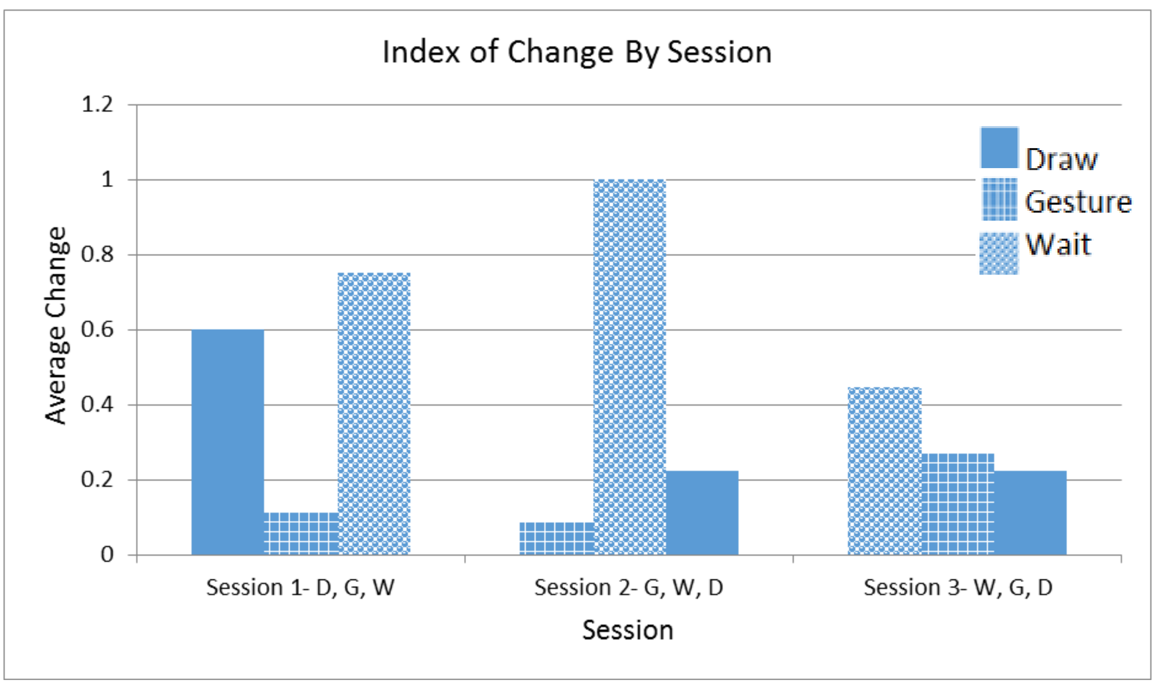


Figure C8: Index of Change By Session



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