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A Multimodal Communication Program for Aphasia during Inpatient Rehabilitation: A Case Study

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Abstract

BACKGROUND—Communication is essential for successful rehabilitation, yet few aphasia treatments have been investigated during the acute stroke phase. Alternative modality use including gesturing, writing, or drawing has been shown to increase communicative effectiveness in people with chronic aphasia. Instruction in alternative modality use during acute stroke may increase patient communication and participation, therefore resulting in fewer adverse situations and improved rehabilitation outcomes.

OBJECTIVE—The study purpose was to explore a multimodal communication program for aphasia (MCPA) implemented during acute stroke rehabilitation. MCPA aims to improve communication modality production, and to facilitate switching among modalities to resolve communication breakdowns.

METHODS—Two adults with severe aphasia completed MCPA beginning at 2 and 3 weeks post onset a single left-hemisphere stroke. Probes completed during each session allowed for evaluation of modality production and modality switching accuracy.

RESULTS—Participants completed MCPA (10 and 14 treatment sessions respectively) and their performance on probes suggested increased accuracy in the production of various alternate communication modalities. However, increased switching to an alternate modality was noted for only one participant.

CONCLUSIONS—Further investigation of multimodal treatment during inpatient rehabilitation is warranted. In particular, comparisons between multimodal and standard treatments would help determine appropriate interventions for this setting.

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Declaration of interest

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Keywords

Aphasia; acute rehabilitation; multimodal treatment; stroke

A substantial portion of people with aphasia have unmet communication needs that persist despite extensive rehabilitation (LaPointe, 2011). Traditionally, augmentative and alternative communication (AAC) strategies have provided support for people with aphasia who cannot meet their communication needs using natural speech alone (Hux, Weissling, & Wallace, 2006). AAC strategies include gesturing (e.g., Marshall et al., 2012; Rose, 2006), drawing (e.g., Lyon, 1995; Ward-Lonergan & Nicholas, 1995), and writing (e.g., Beeson, Rising, & Volk, 2003). Speech generating devices and communication notebooks are also used by people with aphasia (e.g., Ho, Weiss, Garrett, & Lloyd, 2005; Hough & Johnson, 2009; Hux, Buechter, Wallace, & Weissling, 2010; Koul, Corwin, & Hayes, 2005; Nicholas, Sinnotte, & Helm-Estabrooks, 2011). Additionally, instruction in multiple modalities may help people with aphasia develop a system of AAC strategies to use in various situations with various communication partners (Rose, 2013)

Recent research suggests that with instruction many people with moderate to severe aphasia learn to use alternative modes of communication in structured settings; however, many individuals do not use these alternative strategies in natural situations (i.e., these strategies do not generalize) (Garrett & Kimelman, 2000; Purdy, Duffy, & Coelho, 1994; Yoshihata, Watamori, Chujo, & Masuyama, 1998). Part of generalization to natural situations includes the ability to attempt a second mode of communication when first attempts are not successful, thereby repairing a communication breakdown. For example, someone with aphasia may learn to draw and gesture a specific concept. When experiencing difficulty drawing the concept to express his or her intent, he or she may switch to the use of gestures to communicate the intended message and repair the communication breakdown.

Purdy and VanDyke (2011) hypothesized that the limited success that people with aphasia have in using multiple alternative modes of communication may relate to the design of traditional modality training programs. Traditional programs teach each modality (e.g., gesture, write, point to a picture) separately from the other modalities. For example, gestures are taught first for a set of target concepts. If additional alternative modes are needed, a person with aphasia would be taught the use of drawing to convey the same set of target concepts. This method of instruction may result in difficulty switching among multiple modalities because concept instruction in each modality was provided separately. Thus, the use of alternative modes of expression may not generalize because the modalities remain separate from the linguistic system and as a result, their usage remains dependent on conscious control of switching behavior. In order to switch, individuals must consciously inhibit the natural tendency to repeat the first modality, recognize when an initial communicative attempt is unsuccessful, and purposely initiate an alternative response. These inhibition and switching operations are mediated by executive functions, and executive functioning has been found to be impaired in people with aphasia (Mikola, 2011; Nicholas, Sinotte, & Helm-Estabrooks, 2011; Purdy, 2002).

Purdy and VanDyke (2011) developed a program for people with chronic aphasia that provides integrated modality instruction (Multimodal Communication Training or MCT). MCT differs from traditional intervention programs for people with chronic aphasia because it focuses on teaching multiple communication strategies (e.g., speak, gesture, write, point to a picture) for a single concept in an integrated manner before teaching strategies for another concept, thus linking the nonverbal representations to the linguistic system and potentially facilitating automaticity of switching. MCT is grounded in a two-stage word retrieval framework based on linguistic theories about how spoken naming occurs (Dell, Lawler, Harris, & Gordon, 2003). During the first stage, connections among semantic features result in activation of a lemma or semantic concept. During the second stage, the phonological representation is activated allowing for spoken production of the target word. In this model, difficulty in word retrieval can result from disruption during either stage. Traditional multimodality treatments are hypothesized to allow people with aphasia who have difficulty activating the phonological representations (second stage of framework) to use a method of non-verbal expression to circumvent this difficulty. However, previous treatment strategies have not created a sufficient association between the semantic representations of the concept and the alternative modalities of communication. The innovation of MCT is that it can enhance this connection through integrated instruction of multiple modalities including speech for a single concept. This improved connection will likely result in automatic non-verbal modality use when conversation breakdowns occur due to word retrieval errors.

Implementation of a program incorporating the principles of MCT during acute rehabilitation has not yet been examined and should be explored for several reasons. First, interventions based on studies with participants who have chronic aphasia may not result in the same outcomes for people during acute strategies (Linebaugh, Baron & Corcoran, 1998). Second, targeted use of non-verbal communication strategies during acute rehabilitation may increase patient communication and therefore, reduce potential adverse situations during hospitalization (Downey & Hurtig, 2006). Early introduction of alternative modalities may increase their use during inevitable communication breakdowns, this allowing for increased participation in health care decisions. Third, executive function impairments are common in acute stroke (Zinn, Bosworth, Hoenig, & Swartzwelder, 2007) and using a treatment that incorporates strategies to facilitate executive functioning at this early stage may be beneficial. Finally, people with aphasia and their families are often resistant to the use of alternative modalities and show a preference for therapy focused on spoken expression. Resistance may be related to concern that by focusing on non-verbal communication strategies, spoken expression abilities will decline (Weissling & Prentice, 2010). MCT combines spoken expression with other modalities potentially reducing these concerns and encouraging improved use of alternative strategies.

The current study describes the application of a program based on the principles of MCT, modified for use in acute stroke rehabilitation. The modified program, Multimodal Communication Program for Aphasia (MCPA) treated only 10 concepts (nouns) instead of 20 concepts (nouns and verbs), thus shortening the length of each session. Furthermore, the modified program included instruction in a drawing modality, in addition to the four MCT modalities (i.e., speaking, writing, gesturing, and pointing to a communication board). This

change was implemented to gather information about which modalities would be most appropriate for participants during acute rehabilitation.

1. Method

1a. Participants

Two individuals meeting the study's inclusion criteria (primary diagnosis of acute left hemisphere stroke, moderate to severe aphasia as indicated by a *Boston Diagnostic Aphasia Examination Third Edition* (Goodglass, Kaplan, & Barresi, 2001) Severity Score of less than 2, and primary language of American English) participated in the study. The participants provided informed consent during an initial meeting with the first author.

Participant 1 (P1) was a 49 year-old female who was 2 weeks post a severe embolic left hemisphere stroke when the study began. At this time, she earned a score of 52.2 on the *Western Aphasia Battery-Revised* Aphasia Quotient portion (WAB-R AQ) (Kertesz, 2006) and demonstrated characteristics consistent with Broca's aphasia. Her speech was non-fluent with single word responses and semantic paraphasic errors. The *Pyramids and Palm Trees Test* (PPT) (Three picture version) (Howard & Patterson, 1992) results indicated some impairment in semantic knowledge (raw score of 45 out of 52). She presented with moderate apraxia of speech, although her errors (many semantic) indicated that aphasia played a significant role in her communication impairments. She was right handed prior to her stroke, but due to right hemiparesis at the time of the study, she used her left arm and hand to complete activities of daily living as well as for writing and gesturing. Prior to her stroke, she was a teacher and lived independently.

Participant 2 (P2) was a 55 year-old male who was 3 weeks post a severe embolic left hemisphere stroke at the beginning of the study. Initially, he earned a WAB-R AQ score of 5.7 with an aphasia profile most consistent with global aphasia. His spoken output was limited to a single recurring stereotypical utterance. His PPT score indicated significant impairments in semantic knowledge (raw score of 31/52). Although right handed prior to his stroke, right hemiplegia resulted in use of his left hand to complete activities of daily living. Prior to his stroke he worked in construction and lived independently.

Participants' initial scores on various assessments are available in Table 1.

1b. Procedures

Each participant completed the research sessions in addition to the typical inpatient rehabilitation program (5–6 hours of occupational, physical, and speech therapy per weekday, and 2–3 hours of therapy on Saturdays). The participants' regular therapists were not provided information about the purpose of the study. Research sessions included pre-intervention, probe, intervention and post-intervention sessions (Figure 1).

1bi. Pre-intervention sessions—The participants completed three pre-treatment sessions within the first few days after admission to inpatient rehabilitation. The WAB-R AQ and the PPT were administered during session 1 to determine the severity of aphasia. The primary outcome measures, the CADL-2 and a referential communication task (RCT)

were administered during session 2. Baseline performance on a modality probe task was conducted during sessions 1, 2, and 3 as well as before the first intervention session to determine stability prior to treatment. Due to the short length of stay in acute rehabilitation, additional baseline sessions were not conducted.

Stimuli used during the modality probe task included colored line drawings for 10 high-frequency concepts that could be easily gestured or drawn. In order to demonstrate that the target concepts could be represented in different ways and to enhance the chance of generalization, two sets of pictorial training stimuli representing the target concepts were developed. The line drawings were selected from those used by Rossion and Pourtois (2004) modified from Snodgrass and Vanderwart's (1980) line drawings and similar line drawings found on the Internet. These two image sets were placed on 5½ by 8½-inch index cards for use during probe and training tasks. Prior to beginning the probe task, the examiner reviewed the various communication modalities that would be appropriate to use for the task. Additionally, paper, a marker, and an 11 by 8½-inch communication board containing photographed representations of the 10 concepts were available to the participant. Each photograph was placed within a 4 by 2-inch space in a grid format. The grid measured 2 photographs tall and 5 photographs wide. The examiner showed the participants a colored line drawing of a target concept and asked the participant, "What is this? Show me all the ways you could communicate this". No cues or assistance were provided during probes. The participant had up to two minutes to provide all five target communication modalities (i.e., gesturing, writing, spoken naming, drawing, and pointing to picture). All communicative attempts and the modalities used were recorded.

The participants completed the RCT with a communication partner (i.e., research team member) who was not involved in other study tasks. The role of the partner was to provide feedback to the participant regarding the accuracies of his or her production and to provide opportunities for the participant to repair communication breakdowns. The participants were both instructed that the communication partner would sometimes misunderstand his or her communication attempts. The RCT stimuli were made up of high context photographs depicting a person using the target concept (e.g., man using a saw to cut wood). No objects other than the target concept were featured prominently within the picture. For further description of high context photographs see Wallace, Dietz, Hux, and Weissling (2012). The examiner provided instructions to the participants prior to the task as follows, "You are going to have a picture in front of you. The communication partner has a similar picture. To create a match, you will ask her for the picture in any way you can. She will give you the wrong picture if she misunderstands. You can help her understand." Augmented input was provided to participants to ensure that each understood the instructions (e.g., the examiner pointed to the communication partner and the photographs).

The examiner presented each high context photograph depicting a target concept (e.g., saw) and asked the participant to describe the picture to the communication partner who was unable to view the picture. The communication partner selected a line drawing matching those used during intervention tasks and showed it to the participants to confirm that she selected the correct picture. If the communication partner selected the wrong picture, the participant should have then switched to another modality of communication. To provide

sufficient opportunities for the participant to switch, the communication partner was instructed to provide the participants with an incorrect item 50% of the time (five target concepts) regardless of the accuracy of the participants' production. This approach to increasing the number of opportunities to switch modalities was developed by Yoshihata, Watamori, Chujo, and Masuyama (1998). In the current study, the researchers provided instructions to the participants indicating that the communication partner would sometimes respond incorrectly or misunderstood. These items were predetermined through randomization completed by the examiner. The communication partner had a list of the target concepts with those that should be responded to incorrectly highlighted. For example, even if the participant correctly gestured "saw", the communication partner selected the concept "car", requiring the participant to switch modalities. After the opportunity to switch and produce a second modality the communication partner selected the correct target concept in response to the participant's production. If the participant incorrectly or incompletely communicated the target concept during a second production, the communication partner suggested that the participant move to the next target concept. For the other 50% of target concepts, the communication partner responded based on the participant's production of the target concept. If the production was correct, the communication partner responded with a picture of the correct target concept. If the production was incorrect or incomplete, the communication partner presented an incorrect picture thus providing an opportunity for the participant to switch communication modalities. For each trial, the participant had at least 5 and up to 10 opportunities to switch modalities.

For the RCT, the participants had 15 seconds to respond to the communication partner. The examiner facilitated this interaction by asking the participants "is that your card? If not, can you help her understand?" Otherwise, the participants did not receive any cues or feedback during the RCT. The researchers recorded all attempts and successful use of all communication modalities and modality switching. The RCT was repeated post-intervention and at follow up.

The RCT in the current study differed from Purdy and VanDyke's (2011) study because of the addition of the communication partner's role in promoting switching. That is, the communication partners in the Purdy and VanDyke study did not give wrong answers following any correct production to create additional opportunities to switch. In the current study, the researchers included this communication partner behavior in part because of anticipated improvements in spoken communication during acute rehabilitation. If participants' spoken communication improved such that they could accurately produce the target concepts, switching behaviors may not be required during the RCT. Thus, providing the incorrect responses provided ample opportunities for the participants to demonstrate their ability to engage in switching behaviors.

1bii. Probe and Intervention sessions—The modality probe task was completed at the beginning of every other intervention session (e.g., first, third, fifth, seventh, ninth, and eleventh sessions). During probe sessions, paper, marker, and a communication board containing representations of the 10 target concepts were available to the participants.

Intervention sessions began within 24 hours of the final baseline-assessment session and continued daily (5–6 times per week) until criterion was reached or until discharge from inpatient rehabilitation, whichever came first. Criterion was defined as accurate productions of three out of five modalities produced for at least 7 target concepts; for two consecutive probe sessions. Intervention sessions included the production of the 10 target concepts in each modality. The examiner utilized an errorless learning approach to provide each participant with appropriate scaffolding during the intervention tasks (Wilson, Baddeley, Evans, & Shiel, 1994). During early intervention sessions, the examiner modeled each concept using each of the five modalities and the participants imitated each model. That is, the examiner demonstrated the expected response by stating the name, writing the name, gesturing its function or use, drawing it, and pointing to a communication board representation of each target. Direct feedback was provided by way of oral directions and hand-over-hand guidance. Assistance and cueing gradually faded such that as performance improved, the examiner decreased the use of models and increased the use of oral directions or partial responses (i.e., a single line for the drawing). If participants made errors in production, the examiner provided correct models for the participants to imitate. The order of modality prompted was randomized across target concepts and trials (e.g., name, write, gesture, draw, point; draw, write, name, point, gesture). After producing each modality, but before going to the next target concept, the examiner verbally reviewed and modeled each modality and stated “remember you can use each of these modalities if you are ever misunderstood”. The examiner pointed to the participants’ drawings and writing, as well as modeling each modality.

1biii. Post-intervention sessions—Following intervention, participants completed assessment tasks at two time points: end of MCPA (i.e., post-intervention sessions) and three months after admission to inpatient rehabilitation (i.e., follow-up session). Two post-intervention assessment sessions occurred a few days prior to discharge from inpatient rehabilitation or 24 hours following achievement of established criterion. The first post-intervention session included the RCT and the modality probe task. The second session included the CADL-2 and the modality probe task. The 3 month follow-up assessment session included the RCT, the CADL-2, and the modality probe task.

1c. Data Analysis

The researchers descriptively analyzed modality probe performance to provide information about the types of modalities the participants produced and their accuracy in producing each modality type across sessions. Accurate productions were defined as the expression of a target concept in one of the five modalities such that a naïve communication partner could determine the intended concept. Two members of the research team developed the specific criteria for accuracy and practiced using the criteria by watching videos of other people with aphasia using alternative modalities. Apraxic errors such as phonemic additions, prolongations, repetitions accompanied by groping behaviors were accepted as correct (McNeil, Robin, & Schmidt, 2009). Written words were required to contain at least 90% of the current letters in the appropriate order to be counted as accurate. Each drawing had to include three to four lines that the researchers agreed were required for each drawing to be counted as accurate. Only gestures that used the correct hand shape were counted as

accurate; however, gestures that were performed with reduced speed or range of motion were counted as correct. Two members of the research team viewed the performance of the modalities and separately scored accuracy. For each modality, accuracy agreement between the two researchers was 100% for both participants.

Switching behavior was determined by RCT and CADL-2 performance. The CADL-2 differed slightly from the RCT in that not every item was used. The reader is referred to Purdy and Koch (2006) for a description of these procedures. Additionally, the definition of switching behavior in the current study differed from that used in previous studies (Purdy & VanDyke, 2011) but was similar to that used in others (Yoshihata, Watamori, Chujo, & Masuyama, 1998). In the current study, switching behavior was defined as any time a participant used a second modality following an attempt with a first modality. For example, switching behavior occurred if the person first tried pointing to a communication board but was unsuccessful, then used a gesture to communicate the same target concept. The difference between the definition in the current study and previous examinations of this behavior is that the current study accepted switching from non-verbal mode to another non-verbal mode as switching behavior while previous studies (e.g., Purdy & VanDyke, 2011) assumed the first communicative attempt would be speech and use of any non-verbal modality was considered a switching attempt.

In the current study, the researchers sought to account for both attempts and successful switches. Thus, two scores were gleaned from the RCT and modified CADL-2 results. First, the researchers counted the number of accurate expressions of target concepts each participant produced. Only first attempts were scored for the modality accuracy score, thus the highest score possible was 10. The researchers also recorded a switching accuracy score including the percentage of times participants successfully switched modalities. This total possible number of successful switches ranged from 5 to 10 depending on participants' success with initial production of the target concepts. Thus, the participants received scores that reflected attempts at switching and the accuracy (success) of their switching for those attempts (i.e., Attempts/Opportunities and Successes/Attempts). In addition to the scores collected, the researchers also recorded the type of modalities used during opportunities to switch modalities.

2. Results

Results describe the findings from the modality probe tasks (Figure 2), as well as the pre-intervention and post-intervention RCT and CADL-2 scores (Tables 2 and 3). Results from each participant are discussed separately below.

2a. Participant One

During P1's three pre-intervention modality probe tasks, she primarily attempted spoken and written communication, although she also pointed to the communication board. She produced the target concept accurately using 1.17 modalities on average across the first three trials. P1 reached criterion during inpatient rehabilitation stay after 10 intervention sessions over 16 days. Of note, her course of study completion was different from expected due to a 4-day medical break from the study. P1 completed 5 probes during the intervention

period. Across these probes she attempted to use all 5 modalities with an average accuracy of 2.62 per target concept. During her two post-intervention modality probes, she accurately produced on average 3.85 modalities per target concept. At the time of the 3-month follow up session, P1 accurately produced an average of 4.40 modalities per target concept. The increased accuracy in production of various modalities was reflected in her performance during the RCT and CADL-2.

During the baseline RCT, P1 was successful on her first attempt with only two concepts. One of the concepts was predetermined for forced switching behavior. Thus, she had 9 opportunities to switch modalities. Of those 9 opportunities, she attempted to switch (i.e., she accurately or inaccurately used a modality different from the first attempt) for one target concepts. Specifically, when her first attempt to write the word toothbrush was unsuccessful she attempted to use the communication board to communicate this concept. Additionally, this single attempt was successful in that she accurately used the communication board to communicate the target concept. For those opportunities that she did not attempt to switch, she either attempted the concept in the same modality a second time ($n = 3$) or did not respond ($n = 6$).

Regarding use of various modalities, for the two concepts she produced accurately on her first attempt she used the written and the spoken modality respectively. Her unsuccessful attempts included six attempts to write the target concepts and two attempts to use speech. As stated above, her one successful switch occurred with use of the communication board.

Immediately post-intervention, P1 was accurate on all of her first attempts. Thus, she only had opportunities to switch on 50% of the target concepts ($n = 5$). Of these five opportunities to switch, P1 attempted to switch for three target concepts. All attempts to switch were successful, in that she accurately produced three target concepts with a modality that differed from the first attempt. For those concepts that she did not attempt to switch, she used of the same modality as the first attempt. Regarding post-intervention RCT modalities use, P1's first attempts included spoken expression (3 concepts), drawing (6 concepts), and pointing to the communication board (1 concept). For the first attempt at two target concepts, she combined spoken expression with other modalities (speech plus communication board and speech plus gesture). For the three instances of switching behavior, P1 switched from drawing to speaking, drawing to pointing to the communication board, and speaking to drawing. All modalities productions were accurate.

At the 3-month follow up RCT, P1 had accurate productions on all target concepts for the first attempt. She also switched during each of the five opportunities to switch to another modality and produced those modalities with 100% accuracy. During first attempts she used spoken communication and the communication board. Her switches included switching from the communication board to drawing plus speech, and from the communication board to speech.

Overall, P1 improved her communicative performance during the CADL-2 from pre-intervention to post-intervention and follow-up testing. In regard to the modified scoring used to detect changes in switching behavior, P1 also improved. Specifically, she initially

attempted to switch during 13.33% of failed communication attempts and at follow-up she switched during 75% of failed communication attempts. These changes mostly reflect an increased use of gestures when spoken communication was inadequate to convey a particular message.

2b. Participant Two

During P2's three pre-intervention modality probe tasks, he only attempted to use speech and all of his spoken communication attempts were inaccurate. P2 did not reach criterion during inpatient rehabilitation stay, but completed 14 intervention sessions over 16 days. During this time, he completed six probes. A shift to attempting to use modalities other than speech began immediately following initiation of intervention (Probe 4); however, he continued to attempt to speak often while pointing to the communication board simultaneously. Early on, he relied mostly on spoken attempts which were always inaccurate, written attempts which were also inaccurate, although some single letters were correct, and pointing to the communication board with which he was always accurate. Eventually, after six treatment sessions he began to successfully use drawing with which he demonstrated nearly 100% accuracy for all attempts. After the twelfth treatment session, he began attempting to use up to four modalities with all target concepts (i.e., writing, drawing, speaking, and pointing to the communication board). During two post-intervention modality probes, he attempted an average of three to four modalities per target concept with 100% accuracy using the communication board and drawing. P2 was not available for the 3-month follow-up session.

During the baseline RCT, P2 only attempted to use speech. No switching attempts or other modalities were observed. Additionally P2 mostly used spoken communication during administration of the CADL-2, only pointing to test items as appropriate based on the testing instructions. No switching behaviors were observed. At the post-intervention RCT, P2 continued to only use speech, although he gestured (i.e., head nod indicating the inaccurate picture) when the communication partner gave him the wrong card. No switching attempts or other modalities were observed. The post-intervention CADL-2 indicated similar results; however, his overall score increased from 6 to 10. Although switching behavior was not observed, P2 used accurate gestures to complete more items on the post-intervention CADL-2 than he did prior to treatment.

3. Discussion

These two cases represent the first application of a modified MCT in acute stroke rehabilitation. Few studies have examined the use of alternative modalities during inpatient aphasia rehabilitation. Those that have examined this issue have not focused specifically on functional use of the strategies or switching behavior (e.g., de Jong-Hagelstein, van de Sandt-Koenderman, Prins, Dippel, Koudstaal, & Visch-Brink, 2011). The current study provides a preliminary examination of the implementation of MCPA that was designed to promote alternative modality use and switching behavior. Of note, data about the number of sessions completed by the two participants and the ability of one participant to reach criterion during inpatient stay provided preliminary support for further examination of MCPA in this setting. Specifically, P1 reached criterion (i.e., accurate productions of three

out of five modalities produced for at least 7 target concepts across two consecutive probe sessions) during inpatient stay despite a medical complication that delayed MCPA intervention for 3 days. Although, P2 did not reach criterion during inpatient stay, he completed 14 intervention sessions before discharge from acute rehabilitation demonstrating his ability to participate in MCPA.

In addition to completion of MCPA during inpatient rehabilitation, the participants appeared to benefit from MCPA in that each increased use of treated alternative modalities during the modality probe task. These gains were maintained immediately following intervention for both participants and after 3 months for P1. P2 was unavailable for the follow-up session. P1 also showed increased use of alternative modalities on the RCT and CADL-2, and P2 demonstrated increased modality production on the CADL-2. Purdy and VanDyke (2011) also found that one participant was more successful in using the alternative modalities compared to the other. Given his low scores on the PPT, the less responsive participant completed an additional four one-hour sessions of semantic treatment following MCT, and only after these sessions did he increase his usage of alternative modalities (Purdy & VanDyke, 2011). Of note, this participant and the participant in the current study (P2) had similar scores on the PPT which reflected a significant semantic impairment. Use of alternative communication modalities requires access to different types of semantic information. For example, in order to produce a meaningful gesture, one must access the “action” information that is tied to a concept; whereas production of a drawing requires access to visual features of the concept. Future research should address the relationship between semantic knowledge and use of multiple modalities in order to further define appropriate candidates for MCPA.

In terms of switching behavior, P1 demonstrated increased switching attempts and success during the RCT and CADL-2 suggesting increased functional alternative modality use. P2 did not demonstrate an increase in switching behavior during the RCT or CADL-2. One explanation for the lack of switching behavior may be that the training of switching behavior was not made explicit. Yoshihata and colleagues (1998) found they needed to introduce an additional training phase specifically focused on interchange before their participants successfully switch among modalities. Future research may include explicitly training switching behavior.

Another explanation for P2’s lack of switching behavior relates to the degree to which the intervention task was interactive. That is, P2 used drawing and pointing to the communication board accurately during modality probes, but he rarely used these in an interactive way with the intent to communicate a message. Similarly during intervention sessions, he was often trying to copy productions without an emphasis on the communicative value of the task. His heavy reliance on the communication board resembled a picture matching task rather than an interactive communicative task. Therefore, the researchers hypothesize that for some people with aphasia, clinicians should make MCPA sessions more interactive while focusing on the exchange of information. This should be examined in future studies.

Finally, learning alternative modalities likely requires extensive cognitive resources. Previous research has suggested that people with aphasia likely have impairments in resource allocation (Hula & McNeil, 2008). It is possible that learning five alternative modalities was too challenging for P2 because of his severe communication deficits and suspected cognitive impairments (cognitive abilities were not assessed). He may have struggled to adequately allocate the resources needed to perform each modality. Thus, as evidenced during intervention sessions, he required intense modeling of writing, speaking, and gesturing. Augmented input was provided to increase his participation in intervention sessions. In contrast, P1 was very stimuable for the alternative modalities and often required only a non-verbal partial cue during the final intervention sessions. Additionally, P1 demonstrated successful use of one non-verbal communication strategy prior to intervention (i.e., pointing to the communication board) perhaps suggesting that some people with aphasia may be more able to spontaneously produce alternative modes of communication than other people. Therefore, people with the most severe aphasia and with significant deficits in auditory comprehension may benefit from working on only two to three modalities within an integrated multimodal intervention program. Consideration of participant characteristics such as cognitive abilities is warranted. Future studies may investigate inclusion of cognitive flexibility training for some people with aphasia to increase awareness of the need to switch and initiation of switching behaviors.

Although the results and future hypotheses are promising, various limitations highlight the need for additional investigation. First, the primary purpose of this study was to provide an initial description of MCPA in this setting; therefore, the emphasis was placed on exploring whether patients could complete daily therapy and determining whether they would remain in the hospital long enough to complete the treatment. As a result, little attention was paid to experimental control. Thus, improvements noted for participants in modality production and switching behavior cannot be attributed to MCPA alone. Participants also continued to receive speech and language therapy during and following acute rehabilitation which, along with spontaneous recovery, could explain some of the changes observed. Given the improvements in P1's spoken communication, the results of future investigations should also be consider in the context of the findings from previous studies which suggest that some alternative modalities may facilitate spoken communication improvements (e.g., Ferguson, Evans, & Raymer, 2012; Rose, Raymer, Lanyon, & Attard, 2013). Future research should include studies with increased experimental control and should determine if MCPA results in functional communication changes and changes in individuals' level of participation.

Another limitation relates to the descriptive variables of interest in the current study. Because the focus was an initial description of MCPA in a novel setting and the feasibility of such application had not be tested before, the researchers chose to limit the number of variables and items probed throughout the treatment. Therefore, measures of switching behavior which was of particular interest in this study, were only administered prior to and after the implementation of MCPA. Furthermore, only 10 items were included in treatment and probe sessions limiting evaluation of generalization and experimental control using untrained stimuli. Future studies should examine switching behavior during probes throughout treatment which would allow the researchers to gather detailed information about changes in switching behavior as a result of MCPA. Additionally, measures of stability and

clinically meaningful change have not been established for the CADL-2 modified scoring or the RCT; therefore, the researchers cannot use the current data to confirm statistically or clinically meaningful changes as the result of intervention.

In summary, this study sought to examine the application of a multimodal communication program for acute aphasia rehabilitation after stroke. The results suggest that implementation of MCPA in inpatient stroke rehabilitation warrants further investigation to determine whether it improves overall functional communication of people with aphasia.

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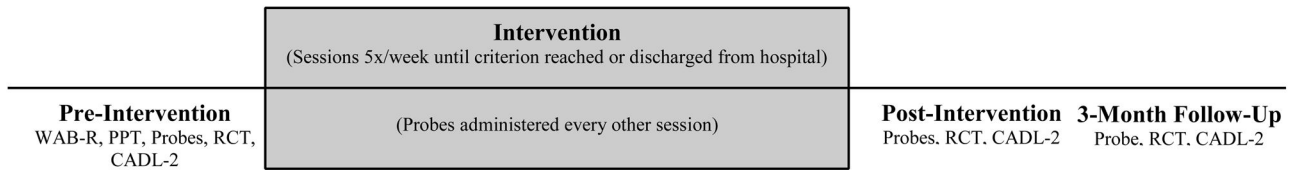
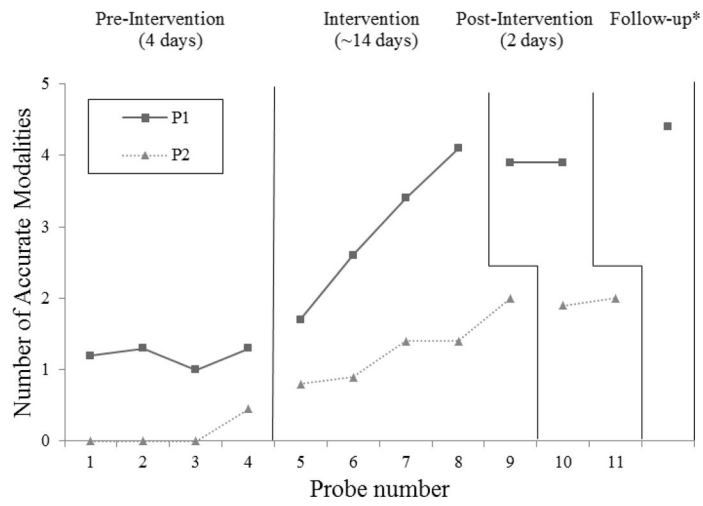


Figure 1.
Study Sessions



*P2 was not available for the follow-up session.

Figure 2.
Participants' Accuracy on the Modality Probe Task

Table 1

Participants' Initial Assessment Results

Participant	Western Aphasia Battery – Revised					Pyramids and Palm Trees Test	
	Aphasia Quotient (100)	Spontaneous Speech	Auditory Verbal Comprehension	Repetition	Naming and Word Finding	Raw Score (52)	
P1	52.2	7	7.9	6.2	5	45	
P2	5.7	1	1.85	0	0	31	

Table 2

Participants' Switching Scores on the Referential Communication Task

Participant	<i>Pre-Intervention</i>		<i>Immediately Post-Intervention</i>		<i>Follow-up</i>	
	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)
P1	1/8 (12.5%)	1/1 (100%)	3/5 (60%)	3/3 (100%)	5/5 (100%)	5/5 (100%)
P2	0/10	0/10	0/10	0/10	N/A *	N/A *

* N/A = P2 was not available for the follow-up session.

Table 3

Participants' Scores on CADL-2 with Modified Scoring

Participant	<i>Pre-Intervention</i>				<i>Immediately Post-Intervention</i>				<i>Follow-up</i>			
	Score (100) (percentage)	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)	Score (100) (percentage)	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)	Score (100) (percentage)	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)	Score (100) (percentage)	Attempts/ Opportunities (percentage)	Successes/ Attempts (percentage)
P1	42 (9)	2/15 (13.33%)	2/2 (100%)	73 (45)	3/9 (33.33%)	3/3 (100%)	85 (67)	3/4 (75%)	3/3 (100%)	85 (67)	3/4 (75%)	3/3 (100%)
P2	6 (<1)	0/21 (0%)	0/0 (0%)	10 (<1)	0/18 (0%)	0/0 (0%)	N/A *	N/A *	N/A *	N/A *	N/A *	N/A *

* N/A = P2 was not available for the follow-up session.