Research Article

Script Training and Generalization for People With Aphasia

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Purpose: To examine the effects and generalization of a modified script training intervention, delivered partly via videoconferencing, on dialogue scripts that were produced by 2 individuals with aphasia.

Method: Each participant was trained on 2 personally relevant scripts. Intervention sessions occurred 3 times per week, with a combination of in-person meetings and videoconferencing, and lasted for 3 weeks per script. This study followed a multiple baseline design across scripts. Measures of accuracy, grammatical productivity, speaking rate, and articulatory fluency were obtained during baseline, intervention, and maintenance phases. Generalization probes were administered by challenging participants to engage in a conversation about their script topic with conversation partners who did not follow the script.

Results: Both participants showed improvement on all dependent variables for both scripts during and after the intervention phase. Generalization samples showed improved grammatical morpheme use and increased rate of speech over prebaseline samples.

Conclusion: There is evidence that script training intervention can improve accuracy, grammatical productivity, speaking rate, and articulatory fluency in script production tasks as well as in more functional conversational tasks. Videoconferencing is a viable method of conducting script training intervention when it is supported by face-to-face intervention sessions, slight modifications to the procedure, and an emphasis on self-cuing skills.

Key Words: aphasia, script training, generalization, self-cuing, videoconferencing

Aphasia often has profound effects on communicative interactions for both everyday tasks and exceptional life experiences. Inability to access fluent and accurate speech in routine daily interactions can have tangible practical and psychosocial consequences. For people with aphasia, life responsibilities that require particularly efficient levels of language production, such as delivering a toast or interviewing for a job, may seem beyond reach. Script training is a treatment approach that can be used with these individuals to address both routine and occasional communication needs. The approach targets highly personalized monologue or dialogue scripts and uses intensive rehearsal until the scripts become automatized and available for use in the person’s life. As will be reviewed in this article, research has shown that script training is a valuable and effective tool in teaching the production of target monologues and dialogues. Evidence for generalization to untrained conversational exchanges is also emerging. Although many individuals may not be able to attend the frequent sessions needed for script training, it is possible that remote delivery may be viable for substantial portions of the treatment. The present study was designed to replicate and extend previous treatment effects for script training, examine generalization to untrained but similar tasks, and explore the feasibility of delivering script training via videoconferencing technology.

Script Training Procedures and Outcomes

Script training is an intervention for people with aphasia in which dialogues or monologues are learned verbatim. The goal is for the participant to achieve “islands of automatic speech” that can be produced fluently that are available for use in real-life discourse (Youmans, Holland, Muñoz & Bourgeois, 2005). Participants progress through script lines following a hierarchy of repetition, choral reading, and independent production based on a determination of mastery made by either the clinician or the participant (Holland, Milman, Muñoz, & Bays 2002; Youmans et al., 2005). The purpose of the approach is to achieve production automaticity via repeated practice of large and meaningful speech units. The standard intervention features common to most previous studies have included the use of highly personalized scripts, a cueing hierarchy directed by the speech-language pathologist (SLP), and 3 weeks of intervention for each script (Lee, Kaye, & Cherney, 2009). Other studies have...
determined intervention duration based on script mastery (Youmans, Youmans, & Hancock, 2011). In these studies, script mastery occurred in as few as eight sessions to as many as 19. Script training has been used for participants with both nonfluent and fluent types of aphasia, including primary progressive aphasia (Cherney, Halper, Holland, & Cole, 2008; Cherney, Halper, & Kaye, 2011; Holland et al., 2002). One study described script training for people with aphasia and concomitant cognitive deficits with variable success (Cherney & Halper, 2008).

The repetitive nature of script training lends itself well to independent practice. To capitalize on this aspect, Cherney et al. (2008) developed software to implement script training intervention via use of an animated therapist. They found results similar to those obtained through one-on-one instruction with an SLP. Similarly, a recent study used short videos of people acting out scripts for a computer-based script training program (Bilda, 2011). After an intensive 10-day practice period, the participants in this study showed significant improvement in producing the target phrases. Most recently, a barcode reader with speech output, the B.A.Bar, was developed to facilitate independent language practice (Nobis-Bosch, Springer, Radermacher, & Huber, 2011). This device has been applied to script training with positive results by allowing clients to practice dialogue scripts by scanning barcodes corresponding to written sentences. These results are encouraging because, in addition to supporting script learning, the use of dedicated software and technology allows people with aphasia to participate in the treatment with autonomy, empowers them to practice independently, and allows for increased frequency of intervention sessions.

The density of intervention sessions is an important consideration. In order for scripts to become automatic, repetitive practice must occur frequently in a short amount of time. Treatment effects have been reported after only 3 weeks of practice on a given script (Cherney et al., 2008; Youmans et al., 2005), and Bilda (2011) reported effects following 3 hr of daily practice for 10 days. For studies employing script training software, participants agreed to 3–3.5 hr of practice each week (Cherney et al., 2008, 2011); however, there was a wide range of variability in actual practice time (Lee et al., 2009). In addition to software training, in-person meetings with an SLP were held to administer probes and ensure compliance. When the primary intervention method was with a clinician, participants agreed to 15 or 30 min per day of independent practice in addition to two to three 30- to 60-min sessions per week of clinician-directed treatment (Youmans et al., 2005, 2011).

Factors such as transportation issues and financial limitations may inhibit an individual’s ability to attend treatment sessions at the recommended frequency. The use of software as described earlier is one way to increase session density, but other methods should be explored as well. One possibility is to offer some of the intervention sessions via videoconferencing. Videoconferencing has been growing as a method of delivering other aphasia treatments (Mieke & van de Sandt-Koenderman, 2011; Theodoros, 2008). Just as studies employing script training software have incorporated in-person sessions once per week, a videoconferencing approach may be particularly effective as a script training method when combined with face-to-face sessions with an SLP.

Positive effects of script training have been reported for a variety of outcome measures, including increased production of words from the target script, grammatical productivity, and speaking rate (Cherney et al., 2008; Youmans et al., 2005). In addition, Youmans et al. (2011) found improved sound production accuracy in participants with apraxia of speech. With increased automaticity, one would also expect improvements in articulatory fluency through decreased hesitations, revisions, and repetitions of the target utterances. Previous studies have not specifically examined effects of script training on articulatory fluency, although the observation of increased speaking rate, replicated in several studies (Cherney et al., 2008; Holland et al., 2002; Youmans et al., 2005), indirectly supports an effect.

**Generalization Effects**

The ability to express oneself fluently and accurately, if only when conveying the limited message in a script, can have profound implications for a person with aphasia and his or her family. For example, scripts have been shown to allow persons who otherwise communicate with great effort and frustration to deliver a speech at a graduation party, interact confidently with coworkers, explain their disability, ask questions at the grocery store, and express affection for loved ones (Holland, Halper, & Cherney, 2010).

In addition to the situation-specific learning demonstrated in previous studies, there is emerging evidence that scripts contribute to improved discourse in natural conversation and on formal language and communication testing. Cherney et al. (2008) reported that participants in their study expressed increased communicative confidence and overall increased ease of communication in exit interviews after participating in script training. Similarly, significant improvement on the Communication Difficulty subscale of the Burden of Stroke Scale (Doyle, McNeil, & Hula, 2003) has been reported following script training (Manheim, Halper, & Cherney, 2009). Bilda (2011) reported higher scores on the Amsterdam Nijmegen Everyday Language Test (Blomert, Kean, Koster, & Schokker, 1994) and the Communicative Effectiveness Index (Lomas et al., 1989) for half of the participants in her study immediately following script training and 6 months after treatment. On the other hand, in their pilot study of computerized script training, Cherney et al. (2008) did not find changes in other measures, including the Quality of Communication Life Scale (Paul et al., 2004) and the Communication Activities of Daily Living, Second Edition.

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1In the present work, we are concerned with articulatory fluency as it applies to disruptive phenomena that interrupt the forward flow of speech, such as hesitations, repetitions, or revisions (Feyereisen, Pillon, & de Partz, 1991). This is in contrast to other applications of the term, including number of words produced on a generative naming task (e.g., letter fluency; Borkowski, Benton, & Spreen, 1967) or grammatical dimensions relevant to the differential diagnosis of aphasia, such as phrase length and grammatical form (Goodglass, Kaplan, & Barresi, 2001). The reader is referred to other works for a more comprehensive discussion of different conceptions of fluency in aphasia (Feyereisen et al., 1991; Gordon, 1998; Kreindler, Mihailescu, & Fradis, 1980).
(Holland, Frattali, & Fromm, 1999). Still, in a larger study of computerized script training, Cherney et al. (2011) reported that posttreatment interviews revealed overwhelmingly positive reactions related to confidence in verbal communication, multimodal communication, and independence in activities of daily living.

There are conflicting results regarding the effect of script training on underlying linguistic competence. On the Western Aphasia Battery—Revised (WAB–R; Kertesz, 2006), some participants showed improvements (Cherney et al., 2008) and others did not (Holland et al., 2002). Bilda (2011) reported that all participants in her study demonstrated improvement on the Naming and Repetition subtests of the Aachen Aphasia Battery (Huber, Poeck, Weniger, & Willmes, 1983).

Youmans et al. (2005) included generalization training as a component of their script training protocol. After each of three 3–4 sentence scripts was mastered, it was practiced with a variety of modifications during which the clinician varied her lines in the dialogue. The script was also practiced with seven new conversation partners who had only general knowledge of the target script content. In an attempt to deviate from the script and challenge the person with aphasia, these novel partners were instructed to intermittently say something appropriate but surprising. During generalization probes, both participants were able to produce all three scripts with 80% to 100% accuracy. Furthermore, their rate of speech increased during generalization probes for most scripts. The authors concluded that generalization likely was promoted by the combination of script automatization and specific generalization practice. The results are promising and raise the possibility that some generalization effects may be possible even without specific generalization practice.

Script Individualization

The use of highly personalized and specific content is at the core of script training intervention, and it is possible that treatment effects are particularly strong for highly motivating scripts (Holland et al., 2010; Lee et al., 2009). Holland and colleagues described a process for identifying motivating topics and developing appropriate scripts. After explaining the goals, limitations, and process of script training, the importance of selecting a personally significant and interesting topic was emphasized. Examples of previous scripts were provided, and the SLP sought to approximate the participant’s prestroke speaking style while drafting the scripts. The specific methods for accomplishing these objectives were not detailed, but it would appear that the process might be enhanced by the use of pictorial material from which the participant could select prioritized areas, topics, and conversational situations, thereby reducing language load on the participant and allowing a broader scope of content to be considered.

Summary of Previous Research

Research to date has shown script training to be a valuable and effective tool in teaching people with aphasia specific monologues or dialogues. Although the optimal length, content, and complexity of scripts are not yet known, there is strong evidence that people with aphasia are good candidates for learning scripts and that expected outcomes include accurate production of script vocabulary and grammaticality of script lines as well as improved articulation, increased speaking rate, and increased communicative confidence. Articulatory fluency has not been examined directly but would be expected to improve with increased automaticity. It has been suggested that highly motivating scripts may yield particularly strong effects, but a functional process for involving the person with aphasia in script development has not been detailed. Finally, although there are indications that script training can improve communicative competence in circumstances beyond script production probes, such generalization should be investigated empirically.

Purpose

The first aim of this study was to replicate a positive effect of training dialogue scripts on content, rate of speech, and grammatical productivity for two individuals with aphasia and to extend the analysis to measures of articulatory fluency. Pictorial material was used to ensure active participant contribution to script development. The second aim was to examine generalization of training effects to less structured contexts where the conversation partner intentionally or unintentionally deviated from the script. The third aim was to explore the feasibility of remote script training sessions via videoconferencing technology. Specifically, we asked the following research questions:

- Does script training intervention improve accuracy, grammatical competence, rate of speech, and articulatory fluency in a target script?
- Does script training intervention affect the accuracy, grammatical competence, rate of speech, and articulatory fluency in more general conversational contexts and when speaking with a novel partner?
- Is remote script training via videoconferencing a viable option to produce script learning effects when combined with in-person sessions?

Method

Participants

Two adults with aphasia, referred to as JC and LE, participated in script training in the context of a multiple baseline treatment design. Both participants were non-Hispanic and Caucasian. JC was a 41-year-old right-handed female with 12 years of education. Six years and 3 months before onset of the study, she sustained a gun shot at close range to the left side of her head. The bullet entered in the superior parietal region and lodged in the temporal pole of the left ventricle. Her recovery was complicated by hydrocephalus and uncal herniation, which required shunting. Repeat brain CT showed extensive damage to the left hemisphere, including superior frontal and parietal lobes, deep parietal lobe, thalamus, posterior insula, and basal ganglia. JC obtained an aphasia quotient (AQ) of 57.2 on the WAB–R and profiled with Broca’s aphasia (see Table 1). A motor speech
examination revealed moderate to severe apraxia of speech. Her monosyllabic word intelligibility was 70% at all octave frequencies from 500 Hz to 8000 Hz. LE did not use any hearing amplification and reported difficulty communicating in noisy environments but had hearing acuity within normal limits, with thresholds <25 dB HL at 4000 Hz.

**TABLE 1. Study participants’ (JC and LE) aphasia quotient and subtest scores on the Western Aphasia Battery—Revised (Kertesz, 2006).**

<table>
<thead>
<tr>
<th>Measure</th>
<th>JC</th>
<th>LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphasia quotient</td>
<td>57.2/100</td>
<td>70.5/100</td>
</tr>
<tr>
<td>Spontaneous Speech</td>
<td>13/20</td>
<td>14/20</td>
</tr>
<tr>
<td>Auditory Verbal Comprehension</td>
<td>5.4/10</td>
<td>7.75/10</td>
</tr>
<tr>
<td>Repetition</td>
<td>4.5/10</td>
<td>6.5/10</td>
</tr>
<tr>
<td>Naming and Word Finding</td>
<td>5.7/10</td>
<td>7/10</td>
</tr>
</tbody>
</table>

The first script development session was the same for both participants, beginning with a general conversation about their interests and experiences. Family members were included in these discussions. As a starting point, participants were shown 27 clipart pictures and simple photographs of topics that had been addressed in previous script training research (Holland et al., 2010). They were asked whether they would like to address any of them in a personalized script. Next, the participants completed a modified card sort using the Life Interests and Values cards (Haley, Womack, Helms-Estabrooks, Caignon, & McCulloch, 2010). Thirty-three cards were selected from the larger set and presented to both participants. The selected cards depicted everyday, relaxing and creative, physical, and social activities and portrayed situations in which one might be particularly likely to communicate or a topic about which one might wish to converse. Topics selected by the participants were discussed in more detail, and each participant identified two topics about which they or they wanted to write a script.

During the second script development session with JC, selected topics were discussed in more detail. The clinician offered suggestions for additional content, and further information was obtained from JC and her son. By the end of the session, two scripts had been drafted. These scripts were read to JC line by line, and she was given another opportunity to make changes. She indicated that she was satisfied with the scripts as they were, so no further changes were made. Her lines in script 1 consisted of 29 total words and included five grammatical morphemes and 19 content words. Her lines in script 2 consisted of 30 total words and included seven grammatical morphemes and 21 content words (refer to the Appendix for a copy of the two scripts for both JC and LE). Complementizers, conjunctions, and null pronouns accounted for the remaining words in the scripts. The percentage of grammatical morphemes per word was 20.7 for script 1 and 26.7 for script 2.

At the second script development session with LE, the clinician brought rough drafts of two scripts. LE was given a written copy, and the clinician read him the scripts. He was asked to make overall changes as he saw fit. Then, the clinician offered an opportunity for editing, and they reviewed each line together. LE added lines, altered wording, and made some of the details more accurate and personal. At the end of the session, he expressed satisfaction with both scripts. LE’s lines in script 1 consisted of 87 words and included 15 grammatical morphemes and 64 content words; his lines in script 2 consisted of 87 words and included 30 grammatical morphemes and 55 content words. The percentage of grammatical morphemes per word was 17.2 for script 1 and 35.6 for script 2.

**Prebaseline probe.** Before any dependent variable probes were administered, a general conversation probe was taken that corresponded loosely in length to the expected target script. The treating clinician engaged the participants in conversations on each topic of their scripts. The purpose of this probe was to provide a point of comparison for the generalization probes.
Baseline phase. At least three baseline probes were administered for each script. As for all other sessions, probes were scheduled ~2–3 days apart. Audio recordings of the probes were obtained for coding the four dependent variables. Throughout the baseline phase, participants had knowledge of the script that was to be practiced, but they had not yet received any auditory prompts or written copies of the script to take home. For probes during all phases, participants were given the entire script dialogue typed on one sheet of paper and were asked to produce it independently, with the clinician contributing the lines for the conversation partner. No cues or strategies were given, but participants occasionally were prompted to move on from a line they could not produce.

Treatment phase. During this 3-week phase, the participants practiced each script in three clinician-directed sessions per week. Thirty minutes of each session were allotted for practicing one script. Overall, participants received 4.0 hr of intervention on their first script and 4.5 hr of intervention on their second script. Videoconferencing technology (Skype; Microsoft Skype Division, 2003) was employed to allow more frequent training sessions than would have been possible otherwise. LE attended two intervention sessions in person (sessions 9 and 12) and six intervention sessions via videoconferencing for script 1. For script 2, she participated in two intervention sessions in person (sessions 12 and 15) and seven intervention sessions via videoconferencing. LE participated in three intervention sessions in person (sessions 5, 7, and 12) and five intervention sessions via videoconferencing for script 1. For script 2, she participated in three intervention sessions in person (sessions 12, 13, and 15) and six intervention sessions via videoconferencing. Probes were obtained at the start of each treatment session and followed the same procedures as during the baseline.

Maintenance phase. After 3 weeks of intervention, scripts entered the maintenance phase. During this phase, participants no longer received treatment but were asked to continue practicing the scripts on their own. After three probes were obtained in the maintenance phase (~1 week), participants were no longer required to practice that script. However, script practice at home was not formally documented. JC reported continued practice of both scripts, but LE reported that he did not practice script 1 after the first week of the maintenance phase.

Generalization phase. Participants attended two generalization sessions ~1 week after script 2 entered the maintenance phase. There were three generalization probes per topic per session. For generalization probe A, a novel partner engaged in a conversation with the participant on the topic of his or her script. The novel partner had limited or no prior knowledge of the content of the participant’s script and was told only the topic and situation. For instance, the novel partner was told, “You are the receptionist at a doctor’s office. The participant is calling you.” For generalization probe B, the treating clinician engaged the participant in a conversation based on new lines that had been written before the session. The lines were constructed so that the participant could use his or her script lines to respond, but did not elicit the script in the familiar order and did not mandate the use of script lines. Generalization probe C was the same as probe B, except that a novel partner administered it with a new set of lines. For all probes, the participant was told that he or she could choose to use his or her script lines, but it was not mandatory. The participant did not have the option of referring to the written script during generalization trials.

Treatment Procedure

Script training. Script training procedures were similar to those used in previous reports (Lee et al., 2009; Youmans et al., 2005). However, because the majority of the treatment sessions were administered via videoconferencing, modifications were made to the protocol to ensure adequate production during remote sessions. To increase participant autonomy, an attempt was also made to increase participants’ flexibility in determining the appropriate level of practice. Initially, for in-person sessions, scripts were trained one line at a time using a cueing hierarchy beginning with phrase repetition, followed by choral reading, and ending with independent production. A new line was learned after the previous line had been produced at least 10 consecutive times at the given cuing level. At any given time, different lines may have been practiced at different stages of the cueing progression.

The initial goal was for participants to produce 10 accurate readings of a line at the current cuing level before decreasing cuing to the next step in the hierarchy. This was the procedure for learning most lines for approximately the first six sessions for JC’s scripts and the first three sessions for LE’s scripts. However, as participants became more familiar with the scripts, this criterion often was not met. As participants became more comfortable with the procedures, script training became more participant directed. For instance, if participants became frustrated or bored, they had the option to move to a different line before the criterion for the previous line had been met. Similarly, participants could choose to move past a cuing level before demonstrating 10 accurate responses at that level. In practice, both participants were aware of what level of cuing was necessary for achieving accuracy. If the participant could repeat the line perfectly, he or she often opted to work at the level of independent production, rather than repetition or choral reading.

Between five and 10 utterances of a phrase were required before moving to the next line, depending on the complexity of the line, the confidence of the participant, how long the participant had been working on the script, and whether that line had been consistently problematic.

Additional procedures were introduced to address problems that arose as the participants were learning their scripts. For example, difficulty initiating lines was targeted by practicing in the context of surrounding lines and by introducing self-cuing strategies, described in further detail below. The last 10 min of the intervention sessions were dedicated to practicing the learned lines in the context of the script without cues, but with a model as needed. Written scripts were provided at all levels of cuing.

Videoconferencing. Videoconferencing posed a challenge to choral reading due to imperfect timing between the audio and video signals. Even a slight delay in the audio signal
made it impossible for the clinician and participant to synchronize their productions. Therefore, repetition and independent production were the only two levels of cuing used for remote sessions. In order to add intermediate steps of difficulty and more support in learning new lines, the clinician requested that participants practice lines in shorter chunks, even to the level of individual words. In this way, phrase length became the more common mode of hierarchical support for the remote sessions. When a participant could produce a single word 10 times, he or she was asked to produce it in a two- or three-word phrase, increasing length until the entire line was produced.

**Independent practice.** Participants were given a digital recording of their script that was made by the clinician. These recordings were saved on the participant’s personal computer or mobile phone. Participants agreed to 15–30 min of script practice 5 days per week in accordance with their current level of cuing. Practice logs were encouraged but not enforced. In an interview following the study, JC and her family reported practice with the recordings one or two times each week, and informal practice daily without the model. LE reported practicing one script every day, using the digital recordings as necessary. Both participants reported practicing the scripts both on their own and with family members.

**Dependent Variables**

Four dependent variables were derived from the audio-recorded probes that were obtained during the baseline, treatment, and maintenance phases and for the prebaseline and generalization probes, including (a) percent script-related words, (b) rate of speech, (c) percent words with grammatical morphemes, and (d) disfluencies per word.

Total number of words was not a dependent variable, but its definition was important for determining other variables. Total number of words referred to the number of intelligible words the participant used. Contractions were counted as two words. If a phrase was repeated in a different line, both repetitions were counted toward the total number of words. Words uttered quietly by the participant for the purpose of self-cuing were not included in the total word count, nor were exchanges that were clearly not attempts at the script. Filler words, interjections, false starts, and partial words were not counted. Specific definitions for the dependent variables are provided in the next few paragraphs.

**Percent script-related words.** Percent script-related words was a measure of the percentage of content words from the script that were used by the participant. Content words were counted as many times as they appeared in the target script. That is, if a content word was used more than once in a probe recording but only once in the target script, it was counted as only one script-related word.

**Rate of speech.** Rate of speech was a measure of the productivity of speech. It was defined as the total number of words produced by the participant, as described above, divided by the total time in minutes of the participant’s turn. Time was measured using the timer in the software that was used to play the audio file. Time was counted in seconds, rounded up to the nearest second, and then converted to minutes. The conversation partner’s lines were not included in the time. A turn was defined as beginning ~1/2 s after the conversation partner finished speaking and ending after the last word the participant said. Pauses, filler words, and tangents were included. In some cases, the participant’s turn ended with silence that was clearly indicative of the participant thinking because he or she was unable to complete the line but was unwilling to move on. In these cases, the length of the turn was calculated to include those silences, even though they occurred at the end of the turn. On rare occasions, the participant did not concede his or her turn until prompted by the clinician. All prompts were given after ~15 s, although this was not operationalized.

**Percent words with grammatical morphemes.** The definition of grammatical morphemes was based on the work of Brown (1973) in language acquisition. Grammatical morphemes were counted each time they occurred in the script production if they were syntactically and semantically appropriate. However, agreement in number, person, and tense was not required. For example, given the utterance “numbers is hard for me,” the morpheme “is” counted toward the total number of grammatical morphemes, although it does not agree in number. On the other hand, the plural “s” marker was not included for the utterance “I live one hours away” because it was not used appropriately. The percent words with grammatical morphemes was obtained by dividing the number of grammatical morphemes by the total number of words and multiplying that number by 100.

**Disfluencies per word.** Disfluencies were defined as repetitions, revisions, and self-interruptions. A repeated partial word, whole word, or phrase counted as a single disfluency. If any of these units was repeated multiple times, each repetition or revision was scored as a separate disfluency. Self-interruptions occurred when the participant stopped a word or phrase production and inserted an interjection or filler word. Consonant, vowel, or pause prolongations were not scored as disfluencies. We first identified and counted the number of disfluencies, then expressed the number as a proportion of the total number of words in order to yield a more stable measure.

**Reliability.** Interrater reliability scores were calculated for each of the four dependent variables. Twenty percent of the probes from baseline, treatment, and maintenance phases were rescored by two research assistants who were graduate students in speech-language pathology. A 30-min training session was conducted in which each variable was defined using examples from audio recordings that were not selected for reliability estimation. As part of the training, grammatical morphemes and content words in the target scripts were identified. Based on the Pearson product–moment correlation, interrater reliability was 0.91 for percent script-related words, 0.94 for rate of speech, 0.87 for words with grammatical morphemes, and 0.93 for disfluencies per word.

**Results**

The intervention results are presented in Figures 1–4. Each figure represents a different dependent variable, with data from both scripts and both participants presented in each figure. Due to technical difficulties and for logistical reasons, some data points are missing. First, due to errors made while
FIGURE 1. Percent of target script-related words used by each participant (JC and LE) during baseline, intervention, maintenance, and generalization phases. The two scripts for JC are on the top, and the two scripts for LE are on the bottom. An x during the initial phase marks the pre-intervention conversation probe, as this variable was not a relevant measure of that probe. Other xs represent missing data points. The three different generalization conditions are marked by shapes: Triangles represent an unstructured conversation with a novel partner on the script topic, squares represent more structured conversation with the primary clinician, and diamonds represent more structured conversation with the novel partner. Each generalization probe was repeated over two sessions.
saving the recorded probes on the computer, the audio signal from three of LE’s probes became irretrievable before scoring. Data are missing from two sessions in the baseline phase (one in-person and one videoconferencing) and one videoconferencing session during the intervention phase. Second, JC was unable to role-play an improvised interaction with her son during the face-to-face prebaseline probe for her second script, so no data were available for this session. Third, percent script-related words was not calculated for the prebaseline probes because the scripts had not yet been developed at the time. All null or absent data points are represented with an × on the horizontal axis.
FIGURE 3. Percent of words with grammatical morphemes used by each participant during baseline, intervention, maintenance, and generalization probes.
The effect of script training intervention on the percent of script-related words is shown in Figure 1. The two participants differed in their use of script-related words before treatment. As illustrated in the figure and summarized in Table 2, before intervention onset, JC produced only about a third of script-related words, whereas LE produced a majority of words. The scores increased during the intervention phase for both participants. Not surprisingly, the change was greater in magnitude for JC, whose initial use of these...
words was more limited. The baseline for LE’s second script was not stable, showing an increase in the production of script-related words during the last three baseline probes, possibly due to learning from repeated probes. Both participants showed near maximal levels of target word production during the maintenance phase (Table 2), and there was no overlap in the range of scores between baseline and maintenance. Effect size was calculated by dividing the difference between the mean baseline probes and the mean maintenance probes by the standard deviation for the baseline scores (Beeson & Robey, 2006). The weighted mean effect size for each participant and dependent variable was then calculated by accounting for the number of observations (baseline + maintenance; Beeson & Robey, 2006). Effect sizes are presented in Table 3. Based on preliminary standards from single-subject designs targeting aphasia treatment (Robey, 2004), the treatment effect size for script-related words was large for JC (4.97) and small for LE (1.65).

**Rate of Speech**

The effect of script training intervention on rate of speech is shown in Figure 2. Similar to percent script-related words, there were pretreatment differences between the two participants. During the baseline phase, rate of speech was slower for JC than for LE (see Table 2). Baseline measures remained stable for both participants. During the intervention phase, there was a gradual increase in rate for both participants, although this increase was delayed by three to seven sessions. The delay was particularly evident for JC, who showed increased but variable speaking rate after the first three treatment sessions for script 1, and then continued to increase her rate throughout the maintenance phase. Similarly, only the slightest increase in rate was observed for JC’s second script after seven sessions, with further increase during the relatively shorter maintenance phase for this script. Across all scripts, the maintenance phase was associated with consistently higher rates of speech than the baseline phase (Table 2 and Figure 2). Effect sizes were large for both participants (13.08 for JC and 6.52 for LE; see Table 3).

**Percent Words With Grammatical Morphemes**

The effect of script training intervention on the percent of words with grammatical morphemes is shown in Figure 3. Note that the vertical axis for this figure extends to 40% rather than 100% because normal speech would not be expected to include grammatical morphemes in all words. As explained in Script Development, percent words with grammatical morphemes ranged from 17.2% to 35.6% in the target scripts. Accordingly, some pre-intervention differences were noted across scripts (Figure 3, Table 2), but there were no clear differences between participants. The baseline for JC’s first script was not stable, with the last data point showing a trend in the anticipated treatment direction. However, the baseline probes were lower than all probes for both the intervention and maintenance phases. The baseline for JC’s second script showed a trend in the direction opposite of the anticipated treatment effect, and this trend reversed to the anticipated direction during the intervention phase. Participant LE showed a gradual, but limited, increase in grammatical morpheme use for both scripts. The baseline for script 1 exhibited a positive trend in the anticipated treatment direction, thus limiting the demonstration of experimental control. For both participants, the effect size for percent words with grammatical morphemes was small (2.83 for JC and 1.95 for LE; Table 3).

**Disfluencies per Word**

The effect of script training intervention on the final dependent variable, the number of disfluencies per word, is shown in Figure 4, with the axis showing proportions up to 0.25. Baseline phases showed substantial variability for both participants. This variability continued into the intervention phase and then decreased substantially in the maintenance phase. In fact, for JC, the proportion of disfluencies...
increased from baseline to intervention as she was attempting a greater variety of words from the script. For LE, disfluencies gradually decreased with repeated practice, which is a logical finding because he had started producing most of the script-related words during the baseline phase (see Figure 1). There was some overlap in the frequency of disfluencies between baseline and maintenance and small differences in the means (Table 2), substantiated by small effect sizes (0.33 for JC and 1.44 for LE; Table 3). As reflected in the standard deviation within each phase, three of the scripts showed a consistently low frequency of disfluencies during maintenance compared to baseline.

Generalization Effects

Generalization effects for each dependent variable are shown in the last phase of Figures 1 through 4. For generalization probe A, a novel partner engaged the participant in general conversation on the topic of each script. In generalization probe B, the treating clinician deviated from the target script in such a way that would allow the participant to respond using his or her script lines if desired. Generalization probe C was the same as generalization probe B, except the novel partner from generalization probe A engaged the participant in conversation and deviated from the script in a unique way. The effect of treatment on generalization varied, with no trends consistently distinguishing the three different contexts. The variable that showed the greatest improvement from pretraining conversation to generalization probes was the percentage of words with grammatical morphemes: JC produced 8% of words with grammatical morphemes in the prebaseline sample, but in generalization trials, he produced as many as 23% of words with grammatical morphemes in a sample; and LE increased his percentage of words with grammatical morpheme usage from 8% of words to an average of 14% of words for script 1 and from 10% of words to an average of 22% of words for script 2.

Generalization effects also were seen for rate of speech. JC increased his rate of speech from 28 words per minute (wpm) in the pre-intervention conversation sample to 60 wpm during the generalization trials. A moderate improvement was seen for LE’s first script, from 43 wpm before treatment to a mean of 55 wpm after treatment. His rate of speech during script 2 generalization was similar to his rate of speech in conversation before script training.

There was considerable variability in the number of target script words that participants used on each generalization trial. JC used between 14% and 89% of her script content words during generalization trials, whereas LE used between 42% and 73% of his script content words. The number of disfluencies per word was also variable during generalization trials and did not show a significant decrease from the prebaseline probe.

Discussion

The first aim of this study was to replicate a positive effect of training dialogue scripts on content, rate of speech, and grammatical productivity for two individuals with aphasia and to extend the analysis to measures of articulatory fluency. A second aim was to explore how effectively participants generalized learned scripts to less structured contexts. Third, the outcome of combining traditional face-to-face sessions with intervention by videoconferencing was investigated.

The study largely satisfied these aims. The effects of script training intervention were replicated most robustly for rate of speech, but positive effects also were noted for percent of target script words used and number of disfluencies. By introducing a new protocol for probing generalization, we contributed useful information toward understanding how people with aphasia are able to use learned scripts functionally. Finally, we demonstrated that using videoconferencing to conduct script training sessions was feasible and yielded positive outcomes. In the following sections, the effect of script training on articulatory fluency is emphasized, as this had not been studied as a separate variable in previous research. The role of self-cuing is also discussed as an important consideration for future script training.

Script Training Outcomes

Both participants achieved competence on their scripts, allowing them to communicate the entire target messages. They were able to attain a high level of performance and sustain it for at least 3 weeks after treatment had ended. LE achieved a stable level of performance on all variables for both scripts in 2 to 3 weeks. JC achieved stability for use of script-related words, grammatical morphemes, and articulatory fluency on her first script 3 to 5 weeks after script training was initiated. Her speech rate continued to increase during the maintenance phase, suggesting that she had not reached her potential at the conclusion of the study and would have benefited from continued training. Probes for all variables showed continued improvement during the maintenance phase for JC’s second script, suggesting that she was still mastering her lines in this dialogue.

Lee et al. (2009) reported mean percent change in content words and percent change in rate for 16 participants. In their study, mean change in percent content words was 45.72, and mean percent change in rate was 137.48. Rate was defined as script-related wpm. In the present study, mean change in percent content words was 57.5 for JC and 28.65 for LE. Percent change in total wpm was 364.5 for JC and 207.0 for LE on average. It is likely that JC showed greater percent change for both of these measures simply because she had more room to improve from the initial probes. Overall, the magnitude of improvement on these variables is similar to results from prior research.

The effect of script training on articulatory fluency was of particular interest in this study, as it had not been studied in isolation in previous research. By the end of intervention, both participants produced substantially fewer disfluencies than during the baseline phase. However, disfluencies followed an interesting pattern in many cases, with an initial increase immediately after initiating treatment, followed by a steady decrease. This is presumably because participants made more attempts at target words and phrases at the start of script learning. Once the participants became more competent in their scripts, the number of disfluencies decreased to levels lower than baseline. A similar effect was observed for
rate of speech, with a reduced speed at the beginning of intervention followed by an increase as the participants continued to practice their scripts. This pattern is in contrast to their pattern of improvement for grammatical morpheme and script word usage, which was toward gradual improvement.

Disfluencies at all stages of the study were mostly self-revisions. They included whole-word and part-word repetitions. Repetitions and revisions were mostly attributable to phonetic errors (repeat–repeat) and part-word repetitions (in–interest), but some revisions were also triggered by verbal paraphasic errors (record–repeat). The type of errors remained fairly consistent for all probes, although the initial attempt tended to be more similar to the target during later treatment sessions. The time between sequential repetitions also decreased in later probes, indicating that the participant corrected the error more quickly than in earlier probes.

The participants in this study spent 1.3–1.5 hr each week in direct intervention. They were asked to practice on their own 5 days each week for 15 min. Regrettfully, we did not sufficiently encourage the participants to keep records of their independent practice, so that variable is largely unknown. In any case, the amount of intervention in this study is likely less than in previous studies. In a review of treatment intensity, Lee et al. (2009) reported that for 17 participants using computerized script training, weekly treatment time ranged from 1.9 to 16.9 hr. Participants who learned 20 short scripts received 3 hr of video-based script training every day for 10 days (Bilda, 2011), which is more than three times more intervention than our participants received. Similarly, participants with apraxia of speech received 2 to 3 hr of weekly intervention by Youmans et al. (2011). Other studies have offered treatment intensity similar to the present study, but the scripts were significantly shorter (Youmans et al., 2005). Although correlation between amount of treatment and amount of improvement (Lee et al., 2009) is not disputed, our results indicate that positive outcomes from script training may not require as many hours of intervention as previous researchers have suggested.

The participants in the present study were similar to participants in other script training studies with regard to age, time post onset of aphasia, type of aphasia, and severity of aphasia. The inclusion of JC, who had suffered a traumatic brain injury, adds to the emerging research that positive outcomes for script training are not restricted to people with left-hemisphere stroke.

**Generalization**

The generalization probes in this study offered a preliminary but informative assessment of participants’ abilities to use learned scripts in functional situations. The dependent variable most sensitive to the comparison between these probes and prescript training conversation was the percentage of words with grammatical morphemes, which increased by between 5 and 12 percentage points from prebaseline probe to generalization probes for the two participants. A likely explanation for this effect is that during generalization probes, both participants used many of their script lines, which included more grammatical morphemes than they may have used spontaneously.

In contrast, disfluencies per word did not decrease from pretraining conversations to generalization probes. The generalization probes represented the first time that participants were asked to retrieve lines out of context without a written copy of the script, which appears to have led to multiple attempts at target words. Generalization effects were seen for rate of speech, but inconsistently, as LE only showed improvement on script 1 for this variable.

During the generalization probes, both participants often chose to use spontaneous utterances instead of scripted lines. That is not to say that they did not use their scripts when responding to generalization probes. Over the course of the six probes, both participants used elements of all lines from each script, with the exception of only one line that was unused by LE. In this way, the participants demonstrated achievement of the basic objective of script training, which is to have access to islands of speech for use in untrained situations. In some cases, participants used script lines as a springboard for introducing new subtopics to the conversation. For example, LE used lines from his script about politics to introduce new topics during conversation with a partner who was admittedly less versed in current events and therefore was having trouble introducing new topics herself.

The participants in this study demonstrated the ability to use learned scripts more flexibly than they were trained. This performance seems to extend the findings of Youmans et al. (2005) that learning a script can improve discourse in less structured social contexts. In contrast to the previous study, JC and LE showed evidence of generalization, even though they did not receive generalization training. Long-term follow-up of learned scripts and general communicative competence were not addressed by the current study.

**Videoconferencing**

The majority of intervention sessions (76% for JC and 65% for LE) occurred through videoconferencing. The substantial amount of intervention time that occurred using this method did not seem to influence the rate of learning negatively, and no differences were observed between probes elicited in person and probes elicited via videoconferencing. Remote sessions allowed participants to meet with the clinician regularly, conserving time and money. Thus, it appears that videoconferencing, supported by face-to-face intervention sessions, is an efficient, economical, and viable method of delivering script training intervention.

Still, videoconferencing sessions had unique challenges. In particular, choral reading was difficult due to asynchrony between the audio and visual signal, and the quality of visual cues was poorer than that available in person. When a participant was having difficulty with a particular word or phrase and required practice with choral production, it was deemed most efficient to defer working on that line until the next in-person session. Because most intervention sessions were through videoconferencing, these limitations led to choral production not being used for much of the training. The fact that both participants managed to learn their scripts suggests that this intermediate step perhaps is not obligatory. By breaking script lines into shorter phrases during practice, we allowed for more intermediate levels of difficulty,
which may have compensated for the limited use of choral production. It appears that choral production and progressive phrase length are both useful tools in script training. Their relative utility may depend on practical circumstances, individual skill differences, and/or participant preferences.

Self-Cuing

Throughout the intervention, it became evident that self-cuing was a highly useful strategy for both participants. In particular, difficulties with choral reading during remote sessions necessitated the addition of self-cuing strategies as an intermediate step between repetition and independent production of both shorter phrases and full script lines.

Initiating script lines and retrieving words were challenges for JC. A few sessions into intervention, she was able to produce whole lines on repetition but was unable to progress to independent production. On the third intervention probe for script 2, JC produced only 10 content words. However, when she was cued with the first word of each line, she produced 15 out of 19 content words. At that time, JC started using self-cues with some assistance to initiate two lines in her second script. For example, she was able to use the name “William” as a cue for a line beginning with the auxiliary “will.” JC used these strategies successfully and was able to fade the cue once the line became more automatic.

LE was very skilled at connecting less familiar words with more familiar words that were phonemically or semantically related, and he used this skill to overcome word finding and motor planning deficits. This approach consistently resulted in accurate word retrieval and production, so he was encouraged by the clinician to continue to use it. As production of the scripts became more automatic, both participants faded their self-cuing spontaneously.

Although strong self-cuing skills are not imperative to script learning, they appear to be a valuable tool that helps facilitate the process. Thus, encouraging self-cuing skills in conjunction with script training may expedite and facilitate typical script learning procedures.

Study Limitations

Although the aims of this study were met, several methodological shortcomings should be addressed. First, the results and interpretation are limited by the small number of participants and scripts trained. Further, external time constraints limited the amount of time we were able to see the participants. A longer trial would have allowed participants to learn more scripts, thus adding baselines and making the results more robust. With a longer study, we would have been able to explore extended intervention, particularly for JC on her second script. Additionally, tracking participants’ independent practice more precisely would have provided more information about how much time participants actually spent learning their scripts. It would have been helpful to know in more detail how the participants practiced and how often they enlisted friends or family in their practice sessions. This information might provide insight into the outcomes of the study and would better inform standards for future script training. In particular, JC reported minimal independent practice, potentially explaining her relatively slower rate of learning. It is possible that she may have found more opportunities to practice if her auditory script models had been available to her on a portable device, as they were on LE’s mobile phone.

Comparison of generalization probes to pretraining conversations would have been more robust if multiple conversations on each script topic had been elicited. The initial conversation sample may not have been representative of the participants’ spontaneous speech before script training. The missing generalization probe data are also limiting. Furthermore, probing procedures could have been better defined. For instance, operationalizing the amount of time allotted for the participant to search for a word or a line would have made probe recordings more validly comparable to one other. Inconsistencies in this regard may have affected rate of speech measurements.

Finally, the generalization probes were not a thorough examination of participants’ abilities to use learned scripts functionally. Not all script lines were elicited in every generalization probe, and probes were artificial and limited in time. Also, both novel partners were people who knew and had worked with the participants in other capacities. It would have been more informative to measure real-life interactions in which the participant used his or her script.

Future Research

Future studies should more thoroughly describe and more accurately quantify participants’ use of learned scripts in real-life interactions. Both participants reported using their scripts in the contexts for which they were conceptualized and developed. Their conversation partners confirmed this observation, and they also described how parts of the scripts were used in appropriate, but different, contexts. Transfer of script portions to novel conversation topics is both qualitatively and quantitatively different from any information gleaned from formal generalization probes and should be examined objectively. Also, long-term follow-up of script retention and generalized communicative improvement is warranted.

The impact of self-cuing on script learning warrants further analysis to offer useful information about candidacy and parallel treatments for optimal success. Perhaps teaching self-cuing strategies, in addition to the cuing hierarchy, would facilitate script learning and generalization. These findings may have implications for increasing the efficiency of script training.

Finally, the social validity of script training effects may be studied further. In the present study, both participants conveyed a sense of pride and accomplishment in learning their scripts. They reported using all or parts of both scripts in real-life situations and expressed interest in learning more scripts in the future. Future studies should examine participant satisfaction with the intervention procedure and outcome.

Conclusion

The results of this study support the assertion that script training intervention is effective in improving dialogic discourse on a chosen topic for people with aphasia. The
result of generalization probes indicates that people with aphasia are able to use learned scripts in similar functional situations. Furthermore, this study highlighted how people with aphasia focus on different aspects of script training, relative to their impairments and goals. Strong self-cuing abilities appear to facilitate script learning. This study also suggests that videoconferencing may be a useful avenue for script training, as a supplement to in-person interaction with a clinician. It is the authors’ hope that, as treatment protocols become more refined, script training will become an increasingly effective way to improve the functional speech of people with aphasia in situations that are important to their interests and goals.

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References


Appendix (p. 1 of 2)

Study Participants’ (JC and LE) Training Scripts

JC’s Scripts

Script 1
Clinician: Hi, nice to meet you.
JC: Hi. Please be patient. I was shot in the head.
C: Oh my. I’m sorry to hear that.
JC: I have aphasia.
C: What is aphasia?
JC: I know what to say, but I can’t get it out.
C: Okay. Can you understand me alright?
JC: Yes, I understand well.

Script 2
JC: Come here. I need your help.
Clinician: Okay.
JC: How are you doing?
C: Okay. I have a Russian test tomorrow.
JC: Good. Are classes hard?
C: Yes.
JC: Do you have homework?
C: No.
JC: Will you see your friends this weekend?
C: Yeah, we’re going to the movies.
JC: How is art and guitar?
C: Good, I just started a new piece.

LE’s Scripts

Script 1
Clinician: Hello, how may I help you?
LE: I want to make an appointment.
C: Okay.
LE: I had a stroke and do not speak well, but I understand everything. Numbers are hard for me.
    Please slow down and repeat them.
C: No problem. What is your name?
LE: **. I need my 1 year check-up.
C: Which doctor do you see?
LE: Dr. Watson.
C: Okay. When are you available?
LE: I can come Tuesday, Wednesday, or Thursday mornings.
C: How about this Tuesday at 8 am?
LE: No, I live two hours away. I need time to drive there and after I have to pick-up my children at two thirty.
C: How about Wednesday morning?
LE: Can I come at ten or eleven o’clock?
C: I have an appointment at 11 o’clock.
LE: Can you repeat that?
C: 11 o’clock.
LE: Yes, that’s fine. Thank you.
C: You’re welcome. Goodbye.
Appendix (p. 2 of 2)
Study Participants’ (JC and LE) Training Scripts

Script 2
Clinician: Do you follow politics?
LE: Yes, I am very interested in politics.
C: Are you a democrat or a republican?
LE: I am a democrat.
C: What do you think of Obama?
LE: I like Obama because he’s smart and thinks about everything. He listens to both sides.
C: I agree.
LE: He has not fixed our problems, but we are starting to make progress.
C: So are you happy with the political scene right now?
LE: No, I am frustrated with our government.
C: Why are you frustrated?
LE: There is friction between the democrats in the senate and the republicans in the house.
C: What do you think will happen?
LE: Absolutely nothing! They need to compromise, but they are too stubborn.
C: Are you for or against the health care bill?
LE: I like the health care bill. It still has problems, but it is better than nothing.