

The effectiveness of script training to restore lost communication in a patient with Broca's aphasia

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Abstract

Aphasia is considered as an acquired neurological disorder of communication, which is characterised by the symptoms on all levels of language dysfunction. The current study was planned to explore the outcomes of script training in a patient with Broca's aphasia through quantitative approach using a single-subject-multiple-baseline research design across behaviours. The probes were obtained during the baseline, treatment, maintenance and generalisation phases for tracking the spoken use of scripted content. All the probes were transcribed verbatim and no value of Cohen's Kappa Coefficient (K) was below 0.61, indicating robust inter-rater reliability. The subject learned all six scripts successively and over 80% of mastery level on all dependent variables was achieved. The largest effect size, above 10.1, was reported for the percent of intelligible scripted words (PISW). Script training was found to be an effective therapy for rejuvenating lost communication of patients with severe Broca's aphasia.

Keywords: Stroke, Aphasia, Script training, Language deficit, Automatic speech, Conversational context, Patients with Broca's aphasia, Communication, Rehabilitation, Speech Language Pathology.

Introduction

Aphasia is an acquired neurological disorder of communication resulting from damage to the language areas of brain, causing language disorder.¹ The main cause of aphasia is cerebrovascular accident, i.e., stroke.² A stroke prevalence of 4.8%, which is the highest ever reported prevalence of stroke in the world, is reported in Pakistan.³ Pakistan Stroke Society reported in 2008 that about 350,000 persons suffer from stroke every year, translating the estimated annual incidence of this neurological disorder to be

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250 in every 100,000 Pakistanis.⁴⁻⁷ The incidence of aphasia after an attack of stroke is about 30% in the acute phase of the disease.⁸⁻¹¹ The estimations of the prevalence and incidence of aphasia are based on stroke epidemiology.¹²

All treatment approaches for aphasia are either traditional or functional. The clinical approach for rehabilitation of lost communication should be based on the combination of both traditional, component-based approach and functional, context-based approach. Script training is an approach that integrates both traditional and functional aspects of treatment. This approach tends to restore automatic, natural and unforced context-specific speech production. Thus, script training approach should be introduced and implemented as a treatment intervention for patients with aphasia.¹³

The current study was planned to observe the effectiveness of script training for patients with moderate to severe Broca's aphasia.

Methods and Results

The experimental study was conducted in the Speech Lab of Riphah College of Rehabilitation Sciences, Riphah International University Lahore, Pakistan, in December 2014, on a single subject with severe Broca's aphasia through administering the scripts for the study in Urdu language. The study used a single-subject-multiple-baseline research design across behaviours. It is evident in literature that patients with aphasia are suitable candidates for script training using such a design across behaviours.^{14,15} In the same vein, several single-subject-multiple-baseline studies were conducted to examine script training as an interventional approach to aphasia therapy. In one such study, there were only two individuals; one of them was diagnosed as Broca's aphasia and the other as Conduction aphasia.¹⁶

Unlike a case study, which provides insight by describing phenomenon, in a single-subject experimental design, the researcher manipulated independent variables to obtain causal statements. A single-subject experimental

Table-1: The effect sizes of the dependent variables of the study across all scripts.

	Script-1	Script-2	Script-3	Script-4	Script-5	Script-6
PISW	20.56	10.76	12.61	12.95	20.07	10.15
WPM	7.19	5.33	9.32	7.65	4.5	1.22
EPW	0.98	-1.26	-0.884	0.755	-7.78	-0.236

PISW: Percent intelligible scripted words
 WPM: Words per minute
 EPW: Errors per word.

Table-2: The mean values of PISW across all scripts and script training phases.

	Script-1	Script-2	Script-3	Script-4	Script-5	Script-6
B.P.	7.82	13.16	10.08	11.5	4.21	9.44
T.P.	81.79	72.65	92.6	74.58	71.61	72.86
M.P.	93.75	89.9	93.67	93.87	87.33	85.76
G.P.	62.5	56.76	58.14	----	----	76.7

PISW: Percent intelligible scripted words
 BP: Baseline probes
 TP: Treatment probes
 MP: Maintenance probes
 GP: Generalisation probes.

Table-3: The mean values of EPW across all scripts and script training phases.

	Script-1	Script-2	Script-3	Script-4	Script-5	Script-6
B.P.	0.2	0.33	0.25	0.2	0.29	0.44
T.P.	0.42	0.41	0.47	0.47	0.15	0.68
M.P.	0.28	0.23	0.2	0.28	0.07	0.43
G.P.	0.56	0.5	0.35	----	----	0.22

EPW: Errors per word.
 BP: Baseline probes
 TP: Treatment probes
 MP: Maintenance probes
 GP: Generalisation probes.

research is considered a suitable way in clinical applications where therapeutic value of treatment as an intervention is in focus for the participant of the study.¹⁷ In this study, the script training intervention was applied across six different scripts for the participant. Each script that was to be learned by the participant was considered as "behaviour". Inclusion criteria: stipulated an Urdu or Punjabi speaker who was able to read Urdu transcript prior to the onset of brain injury, having aphasia for at least 6 months post-stroke. A rating of lower than moderate level of disease diagnosis and all speech disorders other than Broca's aphasia represented the exclusion criteria.

Instead of using a standardised tool to assess the severity level of the disease as moderate to severe, the study selected pre-diagnosed patients from an aphasia

Table-4: The mean values of WPM across all scripts and script training phases.

	Script-1	Script-2	Script-3	Script-4	Script-5	Script-6
B.P.	11.63	18.28	15.09	17.49	12.84	32.83
T.P.	31.93	36.15	30.31	35.45	24.39	27.63
M.P.	53.82	50.23	50.99	47.54	48.95	42.52
G.P.	40.41	39.55	29.5	----	----	37.69

WPM: Words per minute
 BP: Baseline probes
 TP: Treatment probes
 MP: Maintenance probes
 GP: Generalisation probes.

treatment group, evaluated and diagnosed under the expert supervision of a consultant speech language pathologist. Three adult right-handed bilingual Punjabi-speaking male patients of moderate to severe 6 months post-stroke Broca's aphasia who could understand and speak Urdu easily and fluently before the disease were selected using convenience sampling from an aphasia treatment group at Executive Speech Clinic, Riphah College of Rehabilitation Sciences, Riphah International University, Lahore, Pakistan. Unfortunately, after 2-3 sessions of intervention, two of the participants quit the study. Perhaps it was mainly that they were not sure whether script training would help them physically and psychologically. One of these subjects had no formal education and showed avoiding attitude towards scientific treatment methods and considered this therapy as a futile exercise due to having some cultural and racial customs that compel the members of society to adopt spiritual non-scientific methods of recovery from all types of ailments. The second quitter attended three sessions of script training but he was under a severe psychological burden due to the physical limitations that had been developed after brain haemorrhage. The researcher tried to make him understand the possible outcomes of this treatment, but his psychological trauma did not allow him to continue the therapy. Then the researcher had to continue the study with only one 36-years-old participant.

Considering the protocol defined earlier,¹⁴ the researchers and the participant collaboratively developed the targeted scripts, which were relevant and functional in the real world for the participant. The participant selected six situations for the scripts' content; everyday needs, introducing himself, phone call, sleeping time conversation, promise with friends, and counting the natural numbers, considering their application in his real life situations. Once the final script topics had been personalised, the participant was free to choose which of the scripts he wanted to practise first, then that script was

considered as Script-1. After finalising the content of the script, the researcher wrote five sentences for the selected topic. After achieving the mastery of one script, the researcher and the participant repeated the same process of script development for the next script. Once the participant demonstrated more than 80% accuracy in producing the monologue script across at least two sessions, the participant was asked to use the script content in a conversational form.

All the sessions were recorded and each of them was transcribed in the Nastaliq script. The scripts' content consisted of an average of 17 words per script. Flesch Reading-Ease Formula was used to assess the reading complexity of the scripted text of all the scripts. The readability scores for scripts 1-6 were 66, 86, 74, 91, 53 and 110, respectively. The score between 60 and 70 is mostly considered acceptable for reading ease.¹⁸ Because Script-6 consisted of only natural numbers and no other word was included in this script, the readability score for Script-6 was more than 100, i.e. its easiness was more than enough.

Simple reading and recording of the untrained scripts was conducted to evaluate discourse production in the baseline probe (BP) to have a pre-treatment assessment of the participant. After the BP, the treatment (TP), maintenance (MP) and generalisation probes (GP) were conducted as post-treatment assessments through obtaining the recordings of the learned scripts. After BP, Script-1 was allowed to enter into the treatment phase. After achieving mastery in two consecutive probes in Script-1, the maintenance phase for Script-1 and the BP for Script-2 were started. During the maintenance phase, the participant was asked to continue his practice for the learned content in the treatment phase on his own. The script that was entered in the maintenance phase was no longer practised during the treatment session of another script. After acquiring maintenance of the entire script for two consecutive probes, the researchers facilitated the generalisation by using functional conversation outside the experimental environment. The mastered scripts were practised with researchers, caregivers and other unfamiliar conversation partners, thus generalisation training in a conversational manner was started. The generalisation sessions took place for each script with novel partners, in different contexts, using learned scripted and un-scripted contents. The participant was not allowed to use his written scripts during the generalisation sessions.

The participant attended 50-60 minutes of in-person sessions, four days a week for 10 weeks. Additionally, the scripts were practised independently at home using video

recordings of the training material. But there was no criterion to ensure the prescribed independent repeated drilling at home except acknowledging the claims of the participant and his caregivers.

The cueing hierarchy used during script training consisted of the researcher's modelling of a target word, the researchers' and the participant's choral production of the word, then the researchers' fading participation, the participant's repetition following the researchers' production, the production with written cues, independently and then the independent production with no cues.¹⁹ The criterion for achieving script mastery for this study was production of the script independently, without having any cueing or feedback, with 80% intelligible scripted words for at least two consecutive sessions.¹⁹⁻²⁴ The cueing hierarchy was used until the participant was able to achieve script mastery. When this criterion was achieved for a script by the participant, script training was then started for the next script until all six scripts were trained.

All probe recordings were transcribed and analysed by the researchers and two second-year graduates who were trained for required activity of investigation. All the recordings of the probes were transcribed verbatim. Dependent variables were derived from the transcribed manuscript. The dependent variables of the study included percent intelligible scripted words (PISW) which were any real or recognisable word produced by the participant, errors per word (EPW) which were a measure of unrecognisable utterances, and words per minute (WPM) which were considered as words spoken by the participant per minute.

Inter-rater reliability was calculated for the transcribed verbatim and all three main dependent variables of the research. One-third of the total transcriptions were rescored and Cohen's Kappa statistics were calculated to get an estimate of reliability among the raters. The relative strength of agreement was measured by calculating Cohen's Kappa Coefficient (K). No value of K was below 0.61 which indicated an 'almost perfect' agreement among the raters on the transcribed verbatim (K=0.84), PISW (K= 0.90) and WPM (K= 0.93), whereas 'substantial' agreement between the two raters was observed on EPW (K= 0.63), thus indicating robust inter-rater reliability.²⁵

The subject showed an improvement across all variables for all the six scripts. The variables of the research that presented the largest effect from the script training intervention were PISW and WPM. As a whole, the subject improved his communicative skills in using increased

percentages of intelligible words and increasing his rate of speech. These improvements were calculated by comparing the scores of MP, obtained as post-treatment value, with BP, obtained before script training started as pre-treatment value.

The effect size, which describes the magnitude of change, was calculated across all dependent variables for each script by subtracting the mean values of BP from that of MP, and then dividing by the Standard Deviation (SD) of the baseline values. A study recommended the standards for the effect size as 4, 7, and 10.1 to establish small, medium, and large effect sizes for a lexical retrieval task, respectively.²⁶ Overall, the effect sizes for PISW were large across all scripts and for WPM were medium for all except Script-6, which was small but robust, as supported by the stable variability shown during MP. The effect sizes for EPW were small, though there was reduction in the mean values of variation across all scripts during the maintenance phase (Table-1).

The subject attended 40 sessions of the script training intervention over nearly two-and-a-half months, with a range of 50-60 minutes per session. Very low percentage of PISW was observed in the baseline phase for Script-1. However, he mastered Script-1 as evidenced by his high PISW in the treatment phase. These high scores for PISW remained stable throughout the maintenance phase, but a drastic decline was observed in the generalisation phase. The same pattern was repeated for the rest of the five scripts. Unfortunately no GP recordings were done for Script-4 and Script-5, because the participant was reluctant to carry out this activity. A positive trend was observed across all the scripts for PISW (Table-2).

The results for EPW were suspicious due to the low inter-rater reliability. A varied pattern of change for EPW throughout all the phases was seen. Based on the mean values of each probe, EPW increased from BP to TP, but decreased during MP and again increased in GP. There was a trend of increase in EPW after starting practice of the scripted contents in the treatment phase. In the baseline phase, the participant was not still exposed to the script training contents and he only produced the words he already knew; not the scripted words. In the treatment phase, the participant was expected to attempt targeted words and to try to produce correct words, whereas he was not expected to produce those words in the baseline phase with least knowledge of the scripts. However, as he became more skilled in his scripts after learning and practising, the number of errors decreased. That is why a decrease in EPW was noted during the maintenance phases of the intervention. Similarly EPW increased in GP except for Script-6, which consisted of

natural numbers only (Table-3).

The obvious effect as a result of the script training intervention on WPM was markedly seen for all the scripts. The mean values obtained for this variable during BP remained stable across all scripts except Script-6, because the subject was already familiar with the contents, i.e., counting up to 10 and his own mobile phone number. The increased rate of WPM during MP reveals that a longer intervention would have produced a greater effect. A general trend was observed during analysis that the scores of WPM decreased from MP to GP (Table-4).

GP data showed a varied range of generalisation effects. The subject attended 13 GPs with varied responses and no trend was consistently observed, but it was suggestive of achieving proficiency on the selected real-life situations. Out of 43 words, the subject produced 34(79%) accurate words for PISW one time in general conversation probes with the researchers for Script-1. The scores for EPW during GP showed an increase rather than a decrease. The participant demonstrated increased scores for WPM during GP compared to BP.

Discussion

Consistent with the results described earlier, the strong and positive effects of script training were replicated through constructing the scripts in Urdu. The effects were most robust for PISW across all six scripts, whereas medium effects were replicated robustly for WPM, except for Script-6. The effects on EPW were also evident, though these effects were small.¹⁴ Contrary to a study where poor inter-rater reliability for disfluencies per word made the result suspect,²⁴ the inter-rater reliability for EPW was 'substantial' that makes the present study robust.

Similar to a study, the subject showed a steady increase in PISW in TP and stabilisation was seen during MP but a differential use of PISW was noted during GP.²¹ The subject not only achieved mastery in his scripts' production but also maintained it after the treatment had ended. This sustained achievement during MP is strong evidence that the content of all scripts was learned and automated. Therefore, the participant's high scores for PISW in MP support the positive effects of script training to be long-standing. The similar long-standing retention of scripted content following script training procedure was reported in an earlier study.²⁴

An average time for achieving mastery criterion in a study was 4 hours per script,²² whereas it was 15 hours per script in another study.¹⁵ Comparably, our subject took an average time of 2.2 hours per script for achieving the

mastery criterion. The type and severity of aphasia disorder and complexity of the scripted content may have contributed to differences in the script attainment time between participants of different studies.²⁴

For the subject, word retrieval was a challenge that he overcame through spending more time learning and practising the simple and short sentences of the scripts in the treatment and maintenance phases. He was able to produce an average of only 1.5 intelligible words per script in BP and an average of more than 59 intelligible words per script in MP.

Unlike a previous study, it was observed that the subject used the scripted knowledge frequently during GP instead of using more spontaneous novel words.¹⁴ The most sensitive dependent variable that showed the maximum difference between BP and GP was PISW. A comparatively less increase in the scores of WPM and an increase in the scores of EPW for GP compared to BP were seen. The best explanation for this fewer increase is that the participant, for the first time was asked to retrieve learned words in some novel context, out of the experimental environment, with novel partners, without having written script copies in front of him. The difficulty in retrieval attempts and expectations of the retrieval time can easily describe why the scores for WPM did not increase achieving the higher scores like that of the scores for PISW. The same factors can provide the justification of why the scores for EPW started increasing in GP.

Contrary to the results of a study showing high use of scripted words in conversational probes,¹⁹ the subject's scores for PISW and WPM remained low across GP. It is possibly the participant's severity level of the disorder that affected his use of scripted words in GP, whereas the participant of an earlier study had moderate level of aphasia and also had some prior exposure to the procedure of script training being a participant of a previous study.¹⁹ The participant of the present study was a pre-diagnosed case of severe Broca's aphasia.

In the course of initial sessions of the treatment phase, the participant felt difficulty in independent and choral production of the target words but after difficult practice of learning some words and sentences he self-cued some new target words with the phonetically similar previously learned words. This strategy made his articulation and production of new words easy and smooth. For example, the participant whispered the learned word 'phal' (fruit) that he had learned in the last sentence of Script-1 to retrieve the new word 'kal' (tomorrow) in the first sentence of Script-3. Although the self-cuing strategy was not imperative to the intervention, it was a very helpful

tool that facilitated the participant in his struggle to retrieve new words.

Regardless of the severity of the disease and the level of improvement achieved through the script training intervention, the participant reported positive response in all dependent variables of the research on all the scripts. During the course of this study, no side effects and contraindications were reported for script training. Instead, the ability to self-cue and motivation of the participant to rehabilitate his lost communication made the therapy easier and more beneficial.

In the South Asian context, essential parameters for the development of scripts in the Urdu language may help and enhance the patients' rehabilitation process for language dysfunction. The researchers had to use the reading ease formula for Urdu scripts that is primarily constructed for English written texts, which is one of the limitations of the present study. It is recommended that a prescribed formula for evaluating complexity level and reading ease for written text in Urdu should be developed and validated. Regarding generalisation skills, it is suggested that a more realistic picture in real life activities, outside the closed and structured experimental environment, must be investigated. The lone subject from the three initially-selected patients represented a sample size which is an important limitation of the current study.

Conclusion

Script training is an effective therapy in improving damaged language and rejuvenating lost communication of patients with Broca's aphasia on the learned scripted topics. Considering the positive outcomes, script training is recommended as an intervention therapy in clinical practice and is needed to be implemented in speech therapy centres across Pakistan.

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