Treating the Repetition Deficit in Conduction Aphasia

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A disproportionate impairment of auditory-verbal repetition is the hallmark of conduction aphasia (Green and Howes, 1977). Warrington and Shallice (1969) suggest that the difficulty in repetition is not necessarily a disturbance of linguistic mechanisms, but rather a reduction of auditory-verbal short-term memory. In support of their theory they provide evidence that patients with conduction aphasia have superior recall or "repetition" in visual input conditions, and suggest that the visual short-term store (STS) is unimpaired.

A number of studies provide support for an intact visual STS as well as a probable intact auditory and visual long-term storage (LTS) which can be used to demonstrate a greater recall or verbal "repetition ability" in patients with conduction aphasia (Caramazza, Basili, Koller and Berndt, 1981; Glanzer, 1972; Kinsbourne, 1972; Sachs, 1967; Saffran and Marin, 1975; Strub and Gardner, 1974; Shallice and Warrington, 1970, 1977; Warrington and Shallice, 1972). However, whether or not visual input can be used to increase auditory-verbal repetition through intrasystemic reorganization has not been addressed. Though Green and Howes (1977) reported mild to moderate impairments in oral reading associated with conduction aphasia, Caramazza et al. (1981) reported that their patient with conduction aphasia had essentially no difficulty orally reading words or sentences. They argued that he processed visually presented words sufficiently well to assign them a correct phonological representation which was adequate for accurate production of the word(s).

This investigation was undertaken in an attempt to test the hypothesis that the intact ability of the visual-verbal system should assist the auditory-verbal system, once stimulated. According to this notion a patient with conduction aphasia and relatively intact oral reading ability should be able to use auditory-visual-verbal repetition to facilitate accurate auditory-verbal repetition.

SUBJECT

RK was a 42-year-old right-handed man who suffered a left CVA with resulting right hemiparesis and hemianesthesia in August of 1985. His motor and sensory deficits quickly resolved, and two months later he was referred for evaluation of his language deficits. A CT scan revealed a large infarct in the mid-posterior aspects of the left hemisphere.

Speech and Language Evaluation. RK was administered the Boston Diagnostic Aphasia Exam, (BDAE), (Goodglass and Kaplan, 1972), and the Porch Index of Communicative Ability, (PICA), (Porch, 1967). The results of the BDAE revealed that RK's speech was fluent, but contained numerous verbal and literal paraphasias which he frequently tried to correct. Auditory and reading comprehension and naming to confrontation were relatively well-preserved as was the ability to read orally. Writing contained spelling and syntactic errors. Most noticeable was a pronounced deficit of auditory-

Table 1. Results of the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1972).

Subtest	Raw Score	Percentile
Articulation Rating	6	50
Phrase Length	4	40
Melodic Line	-	-
Verbal Agility	9	60
Word Discrimination	72	100
Body-Part Identification	20	100
Commands	15	90
Complex Ideational Material	5	50
Responsive Naming	30	100
Confrontation Naming	114	100
Animal Naming	16	95
Word Reading	30	90
Oral Sentence Reading	6	79
Repetition of Words	7	40
High-Probability	0	20
Low-Probability	1	50
Neologistic	0	70
Literal	16	11
Verbal	14	32
Other	0	50
Automatized Sequences	6	60
Reciting	1	40
Symbol Discrimination	10	70
Word Recognition	8	80
Comprehension of Oral Spelling	3	60
Word-Picture Matching	10	80
Reading Sentences and Paragraphs	10	100
Mechanics	4	60
Serial Writing	41	72
Primer Level Dictation	14	80
Spelling to Dictation	6	85
Written Confrontation Naming	10	100
Sentences to Dictation	1	60
Narrative Writing	3	80

verbal repetition which was more evident at the sentence level than for words. (In addition, his auditory retention span was three digits forward, utilizing both verbal and gestural responses.)

On the PICA (Table 2) he obtained an overall mean and percentile score of 13 and 76, respectively. With the exception of the visual modality (in which he scored 15s), his modality mean scores were characterized by delays and incompletes. His percentile scores ranged from the 65th to the 99th percentile.

Table 2. Modality means and percentile scores for the Porch Index of Communicative Ability (Porch, 1967).

	Mean	Percentile
Overall	13	76
Writing	11.23	82
Copying	13.35	70
Reading	13.6	73
Pantomime	12.25	76/77
Verbal	12.78	65
Auditory	13.8	64/72
Visual	15	35/99

METHOD

The disproportionality of RK's repetition problems relative to his other linguistic deficits fits the descriptions of patients with conduction aphasia (Goodglass and Kaplan, 1972). We therefore designed a treatment to investigate his repetition skills by capitalizing on his intact visual processing abilities. The effectiveness of this program was evaluated using a multiple baseline across behaviors combined with an ABAB withdrawal design.

Baseline. Baseline measures of auditory-verbal repetition ability were obtained for two lists of 10 sentences and questions (Appendix). The stimuli were designed to be functional, and were controlled for length and complexity such that RK would read and repeat them orally without error. They were made up of mono- and bisyllabic words of no more than four or five syllables in length. The examiner read the sentece at a normal rate, and RK repeated it. Treatment began when stable baseline measures had been obtained on each list.

Treatment. List 1 was targeted for treatment first. Treatment began by having RK read the sentence aloud three times. If the third reading was inaccurate in any way he was instructed to read the sentence again. This occurred until an accurate reading was accomplished, at which time he was allowed to turn the card over and repeat the sentence without visual input in the no-delay condition. This continued until he had successfully repeated nine of 10 sentences accurately for two consecutive sessions. The process was then repeated for 5- and 10-second delay conditions, respectively.

As List 1 was treated the examiner continued to measure List 2. When criterion was attained for all delay conditions on List 1, List 2 was targeted for treatment identical to List 1. Procedures used in the withdrawal and second treatment phases were similar to those for the baseline and first treatment phases.

Reliability. An accurate repetition was operationally defined as, "a production that did not contain any grammatic, syntactic, or paraphasic error." Scoring was plus/minus. While RK was permitted to correct his repetition errors, responses were scored on the basis of the first attempt only. All responses were tape-recorded, and scored a second time by another clinician. Agreement as to repetition accuracy by the two clinicians using point to point reliability was 100%.

The following independent measures were taken from the pre and post-testing results of the BDAE: Oral Reading, Repetition, and Paraphasias. Auditory retention utilizing digits forward was also reassessed.

RESULTS

Figure 1 shows the percent correct repetitions for Lists 1 and 2 for baseline, treatment, and withdrawal phases. RK completed the first treatment phase of List 1 in eight sessions. He experienced no difficulties with the no-delay condition, and only initial difficulties at the 5- and 10-second delay conditions. When treatment was withdrawn from List 1 and started on List 2, performance dropped slightly for List 1, but not to the baseline level. When treatment was applied to List 2, RK's performance at the no-delay and 5-second delay conditions paralleled that for List 1. (The hash marks indicate a two week interruption in treatment.) He did not, however, reach criterion on List 2 for the 10-second delay condition, and after 14 sessions a decision was made to withdraw treatment and resume treatment on List 1. When List 1 was treated a second time RK performed similarly to the first treatment phase, completing the program in 10 steps. Cessation of treatment on List 2 (Second B phase.) resulted in negligible changes in performance. It should be pointed out, however, that though RK's repetition success on List 2 did not reach 90%, it was consistently 80%, and remained substantially above baseline.

The number of paraphasias decreased, with oral reading and repetition showing negligible changes (Table 3). Auditory retention remained at three digits forward.

DISCUSSION

The results of the experiment are consistent with the proposed hypothesis. RK was able to use oral reading as input for auditory-visual-verbal repetition to significantly increase and maintain his auditory-verbal repetition ability for the treatment stimuli. Wernicke (1874) argued that the perceptual traces involved in speech processes consist of distinguishable sound and sensory images which usually function conjointly, and that "the actual sensory images are able to directly innervate the representation of a word directly." The results of this study clearly suggest a strong role of visual-lexical input in increasing RK's repetition during treatment. More importantly, the treatment facilitated an increase in RK's auditory-verbal repetition during the withdrawal phases when no visual input was provided. RK's increased auditory-verbal ability provides further evidence for a close bond between the auditory and visual channels for encoding speech output. In order for the treatment to have worked it is hyhpothesized that some form of intrasystemic reorganization had taken place. RK's increased auditory-verbal

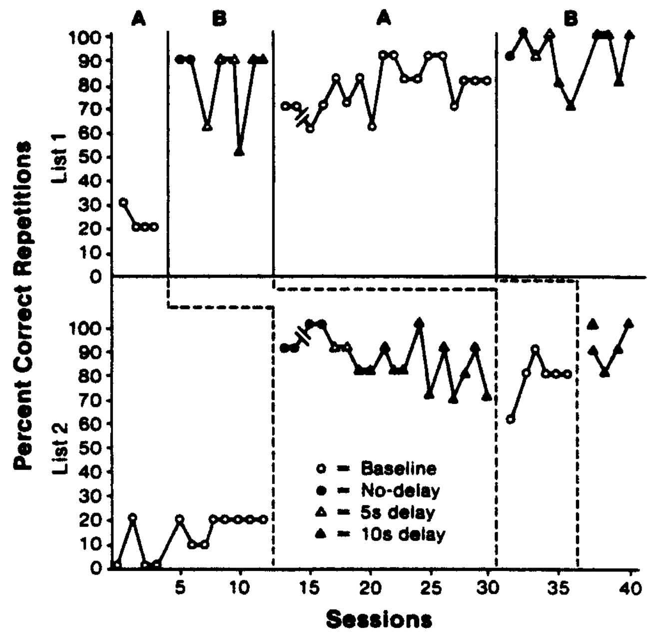

Figure 1. Percent correct repetitions for List 1 and 2 during baseline, treatment, and withdrawal phases.

Table 3. Pre and post-testing results of the independent measures taken from the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1972).

	Pre-treatment		Post-treatment	
	Raw Score	Percentile	Raw Score	Percentile
Paraphasia				
Neologistic	0/12	70	0/12	70
Literal	16/16	10	1/16	80
Verbal	14/24	30	7/24	60
Extended	0/16	50	0/16	50
Oral Reading				
Word reading	30/30	90	30/30	90
Oral sentence	6/10	75	9/10	90
Repetition				
Words	7/10	40	9/10	70
Hi prob	0/8	10	2/8	50
Low prob	1/8	50	1/8	50

repetition ability could have been enhanced by visual-perceptual traces. In addition, it is very likely that this was a learned and retained behavior. Orally reading the sentences followed by rehearsal appeared to provide a mnestic function through simultaneous auditory and, more importantly, visual input stimulation.

Shallice and Warrington (1970) argued that in normal subjects there are parallel inputs into the auditory STS and LTS, as well as a rehearsal loop that keeps information active in the auditory STS. They hypothesized that though the STS is pathologically limited, this does not prevent the normal function of the rehearsal circuit which can generate a normal LTS representation. However, this is only if the lists of stimuli do not exceed the capacity of the impaired STS in conditions that allow for rehearsal. The stimuli in the present study were constructed so that during treatment RK could successfully rehearse the orally read sentences before being asked to repeat. Saffrin and Marin (1975), using auditory input, found that repetition of digits, letters, and high frequency words (implicating LTS) was superior to repetition of low frequency words or nonsense syllables. Therefore, one explanation of the treatment effects could be that auditory images are directly transferred into the auditory LTS. However, Caramazza et al. (1981), in a similar study, reported that their patient had greater difficulty with recall of function words in the auditory than the visual input condition. The fact that RK was able to repeat function words, though in the context of a sentence or question (See Caramazza et al. 1981.) provides evidence that is inconsistent with the possible use of the auditory LTS for repetition.

On the other hand, Warrington and Shallice (1972) provided evidence for a post-perceptual visual store based on markedly different forgetting curves (auditory worse than visual). They argue that better visual repetition performance was not a result of a transfer of the visual information to an auditorally encoded STS for speech output. In other words, they inferred that their patient was not recoding the visual stimuli into an auditory image. This was based on the finding that, unlike normals, with visual presentation of acoustically similar letters, acoustic errors did not exceed chance. However, visual confusion errors with visual input reached significance. It is possible that the results of the present study are consistent with the findings of Warrington and Shallice (1972). The auditory-visual input provided to RK during oral reading could have been processed within the visual STS. RK might have been using the visual STS which allowed for the better repetition in the treatment phases.

Response delays were imposed to allow for elucidation of the data with regard to learning. RK had greater difficulty with the 10-second delay condition (with the exception of the first treatment phase of List 1). If RK's speech output or recall was from the visual STS, then the decline in performance observed in the delay conditions could be the result of normal forgetting from the visual STS. On certain occasions during treatment RK was observed closing his eyes during rehearsal. When questioned about this he stated, "Picture." When questioned further about what he was "picturing" he stated, "See sentence." On the occasions when he was unsuccessful in repeating he often stated, "Gone." Since both auditory and visual input were used, neither can be more responsible for the decline in auditory-visual-verbal repetition. This is if the findings of Warrington and Shallice (1972) with regard to a post-perceptual visual store are questioned. Further studies need to be accomplished. Using an auditory distraction given the same type of task used in this study could rule out auditory rehearsal and provide further evidence not only for the utilization of the visual STS to increase auditory-verbal repetition, but also with regard to delineating whether the auditory and visual systems function conjointly or independently. Of further interest would be the types of errors made with regard to function versus content words in implicating long term or short term storage mechanisms, as well as delineating the changes that might occur in the quality and quantity of language output.

How does one account for RK's increased auditory-verbal repetition ability within the withdrawal phases of both lists? Since RK's auditory short-term memory deficit did not improve as indicated by the post-testing results of the repetition subtest of the BDAE and digit span, it is likely that he was using both auditory and visual LTS. Subjective analysis of RK's errors revealed that he was usually able to paraphrase the stimuli in error, especially with regard to content words, thus implicating some recall from at least the auditory LTS (Saffrin and Marin, 1975). Assuming that patients with impaired auditory short-term memory are not able to accurately recall function words from the auditory STS, but can from the visual STS (Caramazza et al., 1981), it is hypothesized that the repeated (visual) rehearsal that occurred during the treatment phases allowed for the transfer of information into the visual LTS thus allowing RK to utilize the visual LTS to facilitate auditory-verbal repetition.

The fact that the treatment did not generalize to the independent measure of auditory-verbal repetition suggests that RK learned or retained the stimuli. Of further interest is the fact that RK was subjectively observed using the treatment stimuli spontaneously without error. The syntactic and grammatic appropriateness of this output was in contrast with the rest of his spontaneous speech, which contained numerous syntactic and grammatic, as well as paraphasic errors. Again, his spontaneous use of the treated phrases was most likely a result of learning. This raises further questions as to the underlying processes associated with the encoding of speech. Shallice and Warrington (1970) discussed the possibility of sub-groups of patients with conduction aphasia--those that have a disorder of reproduction associated with a language impairment, and those with a disorder of repetition (secondary to an auditory STS deficit) whose spontaneous and imitative speech is unimpaired. Our patient, RK, demonstrated both a language and auditory STS deficit. It is of interest that he could be trained to repeat (and produce) specific utterances in the context of impaired auditory-verbal repetition and spontaneous speech. It would seem, therefore, that a memory trace served as a model for the accurate encoding of speech. However, is that memory trace associated with the processes of spontaneous speech production? The results of this study are inconsistent with this notion, especially with regard to RK's nontreated speech output. The fact that RK's nontreated speech output remained significantly impaired with an unimpaired (or minimally impaired) visual-verbal processing system might suggest that within the speech encoding process spontaneous speech production may be primarily dependent on the mechanisms within the auditory modality. In addition, one could suggest from the results of the present study that the auditory and visual processes associated with the encoding of speech are neuroanatomically and/or functionally related. This is in light of the finding of increased auditory-verbal repetition following auditory-visual input. The results are consistent with the notion of intrasystemic reorganization and provide further evidence of the importance, contribution, and effectiveness of visual-lexical input in facilitating accurate auditory-verbal repetition (or encoding for spontaneous speech production).

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APPENDIX

The two lists of stimuli utilized for treatment

List 1	List 2
1. I want to leave.	1. Where is the bathroom?
2. I need to eat.	2. May I sit down?
3. I'm very hungry.	3. The sink is dirty.
4. Bring me my pills.	4. I need my coat.
5. How are you feeling?	5. Let's have some dinner.
6. I am a painter.	6. We should get gas.
7. My name is Ron.	7. It's a nice day.
8. How much is it?	8. We went last night.
9. Turn on the lamp.	9. Would you like coffee?
10. I had a stroke.	10. Will you call me?