Clinical Aphasiology, Vol. 24, 1996, pp. 109–120

Treatment for Aphasic Phonological Output Planning Deficits

Richard K. Peach

A recent development in clinical aphasiology is the description of aphasic deficits according to the psycholinguistic representations underlying the various activities of language use (Caplan, 1993; Hillis, 1994). New approaches for treating spoken language, reading, and written spelling disorders have emerged using the frameworks provided by cognitive neuropsychological models of language processing (Rothi and Moss, 1992; Thompson, Raymer, and le Grand, 1991). In this paper, these methods are applied to the assessment and treatment of a fluent aphasic patient demonstrating disproportionate impairment of spoken output relative to her abilities in the areas of both listening and reading comprehension and writing. The efficacy of the treatment is described along with the clinical and theoretical issues associated with this approach.

The treatment program utilized a phonologically based approach targeting output disturbances through oral reading. Additional treatments for auditory comprehension, naming, and sentence formulation deficits were administered concurrently with this oral reading program. The plan was developed using results obtained from analyses of the psycholinguistic components underlying the production of single words. In this approach, oral word production is viewed as consisting of two distinct processes: lexical phonological access and phonological planning (Caplan, 1993). This subject's word production deficits were thought to arise from impairment to processes associated with phonological planning. The following evidence was used to support this diagnosis. First, the subject demonstrated not only marked literal paraphasia but also neologistic errors well after she had recovered aural comprehension that was only mildly impaired. Second, her writing exceeded her oral output at initial evaluation and at the time of a subsequent pre-experimental evaluation. Finally, her phonological production was approximately equally impaired for repetition and naming but substantially improved for oral reading thereby suggesting her use of a lexical strategy for the latter tasks. These findings implied that her output disturbances could not be attributable to impairment of auditory lexical access and that they involved the phonological but not the orthographic output lexicons (Caplan, 1993). They also suggested that, while she was able to use the phonological forms of words for lexical semantic access, she was unable to use either of these types of information to access the phonological output lexicon. Hence, oral reading was chosen to improve phonological output planning.

METHOD

Subject

The subject was an 84-year-old, right-handed female who experienced a single, left middle cerebral artery, thromboembolic stroke. Results of CT scan performed at the time of hospital admission demonstrated infarction within posterior insular cortex and the parietal lobe operculum (Figure 1). She was approximately 4 months post onset when she entered into the study and 8 months post onset at its conclusion.

The diagnosis of aphasia was based on results of the Western Aphasia Battery (WAB) (Kertesz, 1982). Initial testing performed at 3 weeks post onset demonstrated a profile of Wernicke aphasia (Figure 2) and an Aphasia Quotient of 48.6. She received treatment for her aphasia during the next 3 months and was reevaluated prior to the beginning of this study. Preexperimental testing demonstrated that her Aphasia Quotient had improved to 70.1 but that she demonstrated disproportionate difficulty in oral expression relative to her performance in the areas of auditory comprehension, reading comprehension, and writing. Oral expressive performance was characterized by neologistic output and word-retrieval failure with frequent ability to write accurately the word that she was attempting to produce. Clinical observation revealed impaired but better preserved oral reading relative to her repetition and naming.

To further evaluate the subject's language deficits, the Battery of Adult Reading Function (BARF) (Rothi, Coslett, and Heilman, 1984) was administered. The BARF consists of six subtests and two appendices. The battery includes subtests for: (1) nonwords, (2) regular words, (3) rule governed words, (4) irregular words, (5) homophone-picture matching, and (6) homophonic nonwords, i.e., nonwords that are homophonic to real

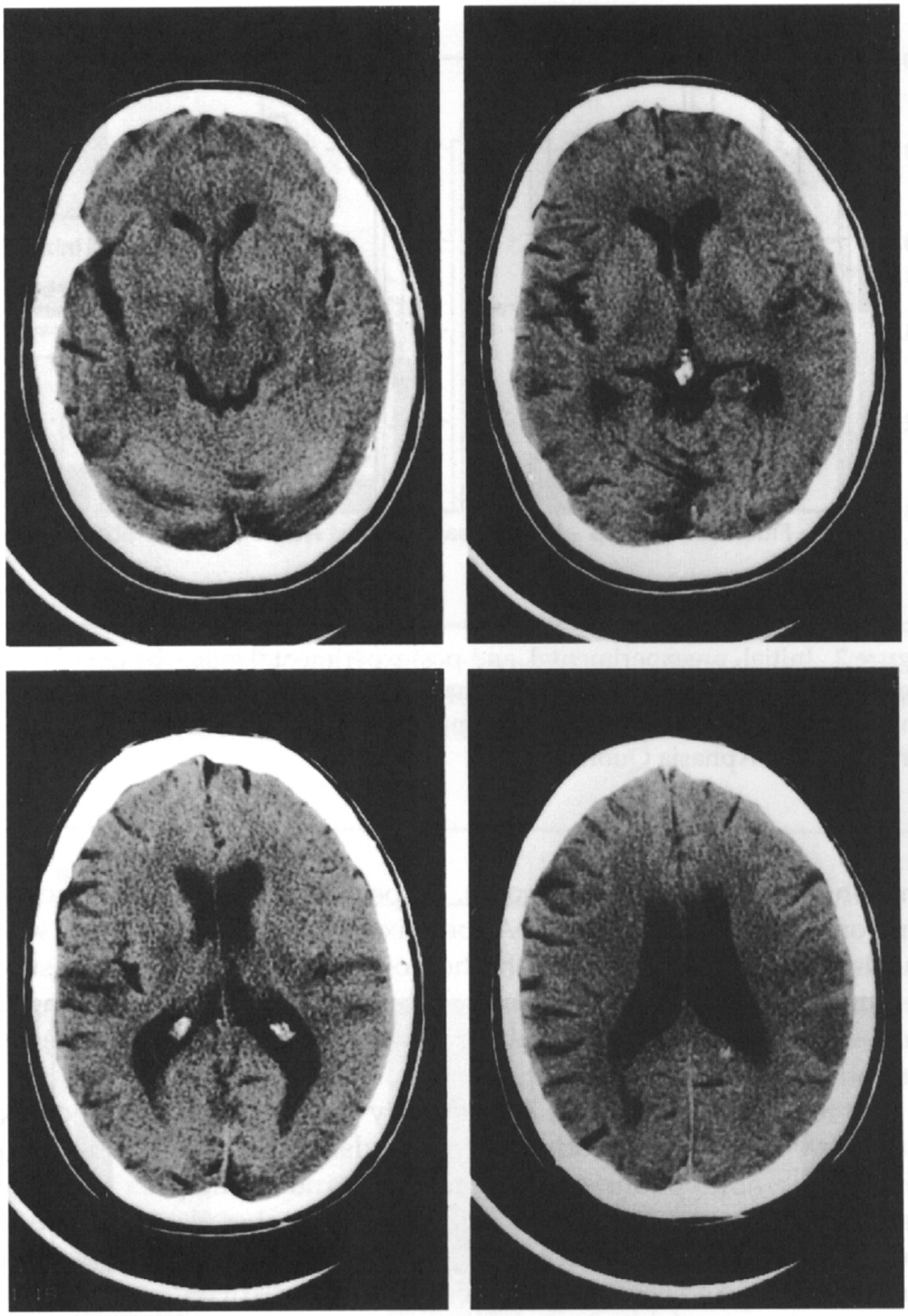

Figure 1. CT scan results demonstrating site of lesion in experimental subject.

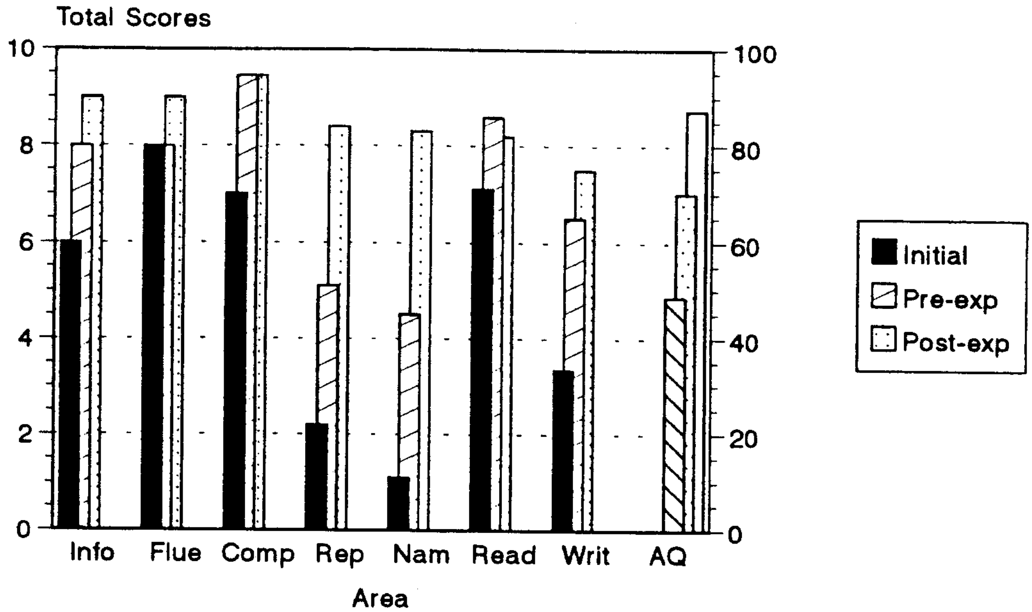

Figure 2. Initial, preexperimental, and postexperimental scores by area for the Western Aphasia Battery (Info = Information Content; Flue = Fluency; Comp = Comprehension; Rep = Repetition; Nam = Naming; Read = Reading; Writ = Writing; AQ = Aphasia Quotient).

English words (e.g., coam, shooz). Appendix A assesses production of functor versus content words. Appendix B assesses homophone writing and is the written version of the homophone-picture matching subtest. Reading skills are assessed by subtests 1–6 and Appendix A. Writing skills are assessed by subtests 1–4 and the two appendices. Responses are scored for both accuracy and error type.

The results demonstrated significantly poorer accuracy for oral production versus written production of words (Figure 3). Reading comprehension for homophone-picture matching and homophonic nonwords was largely preserved (Figure 4). The greatest number of errors were of the phonologic and neologistic types (Figure 5). For example, *inform* was produced as *inborg* and *holy* was produced as *buly*. Each of these errors are consistent with partial failure of grapheme-phoneme correspondence rules (Coltheart, Patterson, and Marshall, 1980; Marshall and Newcombe, 1973). Based upon these findings, it was hypothesized that the subject exhibited a predominate impairment in phonological output planning with lesser deficits in lexical phonology-orthography conversion (Caplan, 1993). That these deficits were not part of a general phonological impairment was indicated by her relatively preserved phonological access for identifying the meaning of homophonic nonwords.

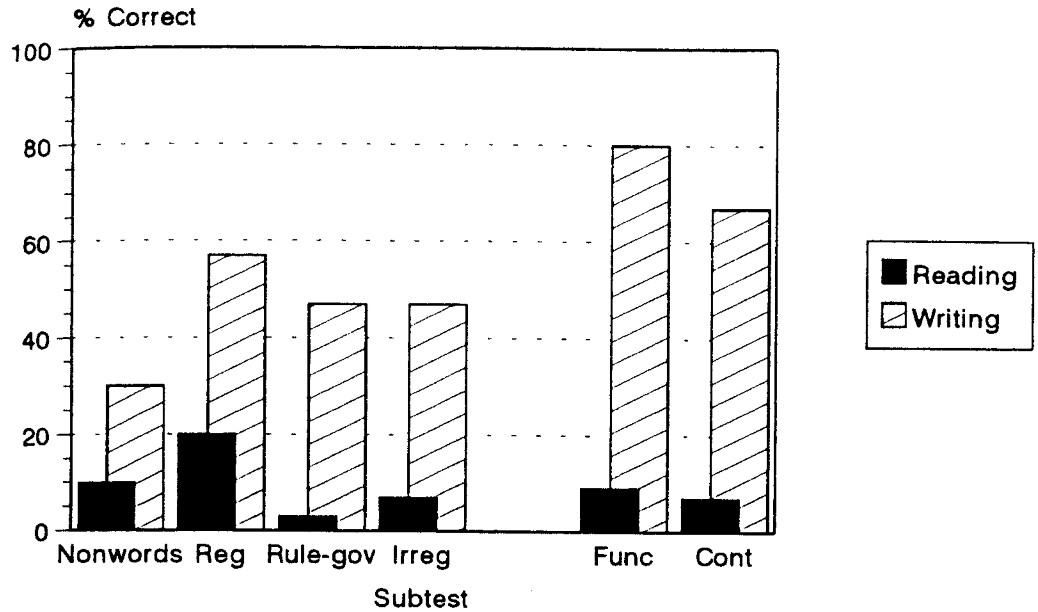

Figure 3. Preexperimental scores for selected reading and writing subtests of the Battery of Adult Reading Function (Reg = Regular words; Rule gov= Rule governed words; Irreg = Irregular words; Func = Functor words; Cont = Content words).

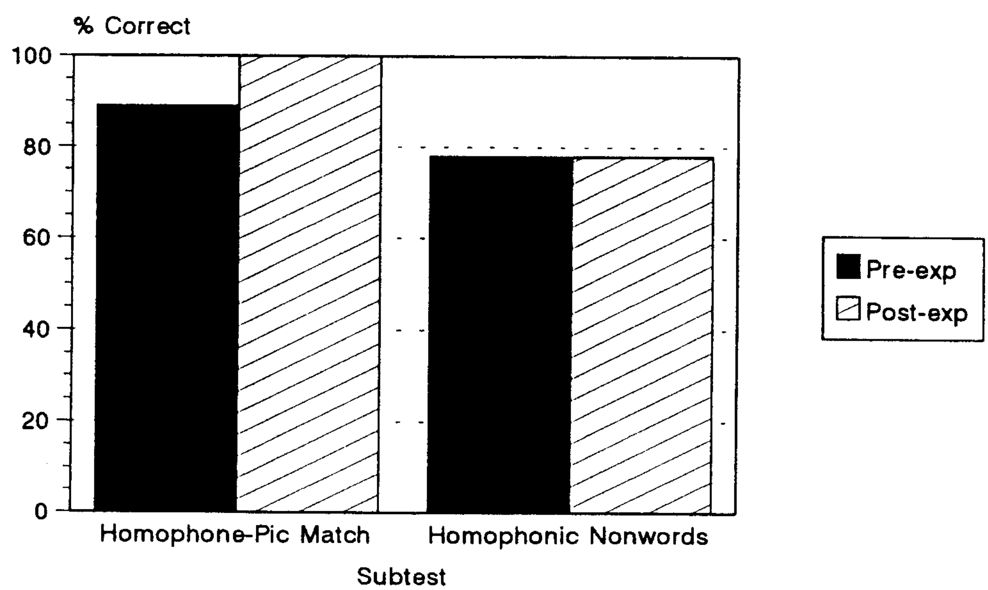

Figure 4. Pre- and postexperimental scores for reading comprehension subtests of the Battery of Adult Reading Function.

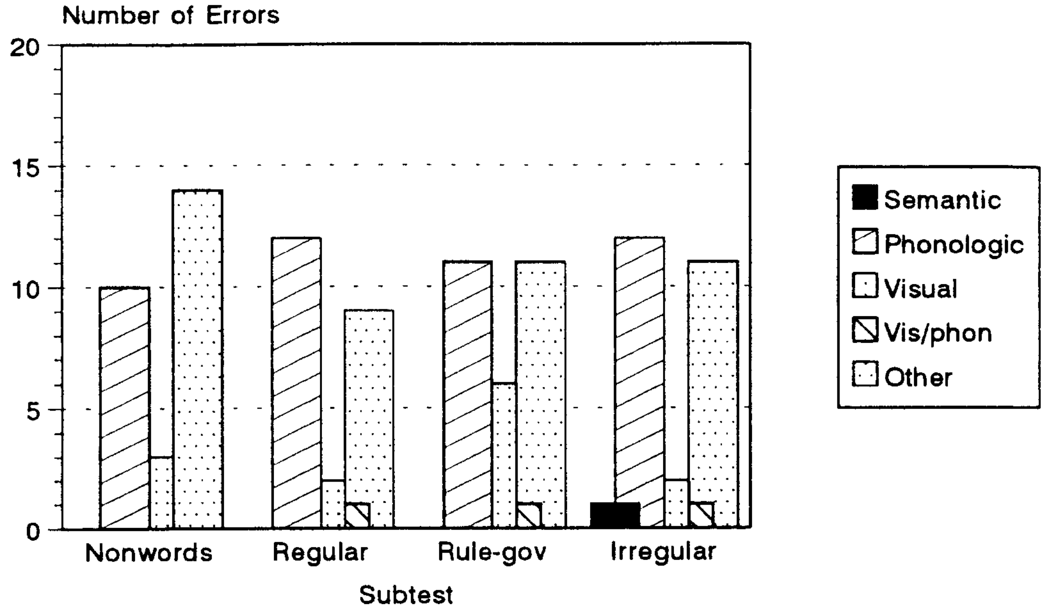

Figure 5. Preexperimental distribution of error types by reading subtest of the Battery of Adult Reading Function.

Experimental Stimuli

The experimental stimuli consisted of 30 bisyllabic words controlled for frequency of occurrence, phonetic context, and part of speech (Carroll, Davies, and Richman, 1971; Thorndike and Lorge, 1944). These stimuli were equally divided into three sets each containing 10 words. The 10 words in each set were comprised of two words randomly selected from a larger list in each of the following five categories: nouns, verbs, adjectives, adverbs, and connectives. Two sets were designated for training. The third set was not trained and was used to examine generalization. Each word was printed in large block letters and affixed individually to 3″ × 5″ index cards.

Design

A single-subject, multiple-baseline design across behaviors (McReynolds and Kearns, 1983) was used to assess the effectiveness of phonologically based treatment on oral reading. Following baseline testing, training was applied sequentially to the two sets of training items. The generalization set was never trained.

Baseline. During baseline sessions, the 30 stimulus items were presented in random order to assess oral reading of each word. Stimuli were exposed for up to 5 seconds. No feedback was provided. In the event of multiple attempts, only the last response was scored. All responses were coded using a 3-point scoring procedure wherein a 2 was assigned to a correct response, a 1 to a self-corrected response, and a 0 to an incorrect response.

Treatment. A phonologically based treatment was used to train oral reading of the target words from sets 1 and 2. On each training trial, a printed word was presented for the subject to read. When a correct or self-corrected response was not produced, the subject was instructed to write the word to increase the salience of the item's phonological features through orthographic-phonologic conversion. If this cue did not result in a correct response, each phoneme produced in error was paired with the same phoneme in a key word, i.e., another word with the target phoneme in initial position that was read with high success. A final cue consisted of the subject's repeating the stimulus aloud when provided by the clinician. Training for each set was continued until a criterion of 90% accuracy was achieved (combined correct and self-corrected responses) over two consecutive sessions.

Generalization Probes. Probes were administered at the beginning of each session. The procedures for conducting these probes were identical to those used for baseline.

Interjudge Reliability. Reliability for scoring of the baseline and probe data was obtained by the clinician administering the experimental task and an independent observer. Prior to the initiation of the study, operational definitions for each response type (correct, self-correct, error) were established. One-third (330) of the subject's total responses were scored subsequently by both observers using the procedure outlined previously. Comparison of results obtained from the two observers for the baseline and probe data demonstrated 98% agreement.

RESULTS

The results of the study are depicted graphically in Figure 2 and in Figures 6–8. Phonologically based treatment appeared to be effective in improving the oral reading of this subject (Figure 6). Maintenance of treatment effects was demonstrated for both sets of training items after the withdrawal of treatment. Generalization of trained behaviors to untrained stimuli was observed.

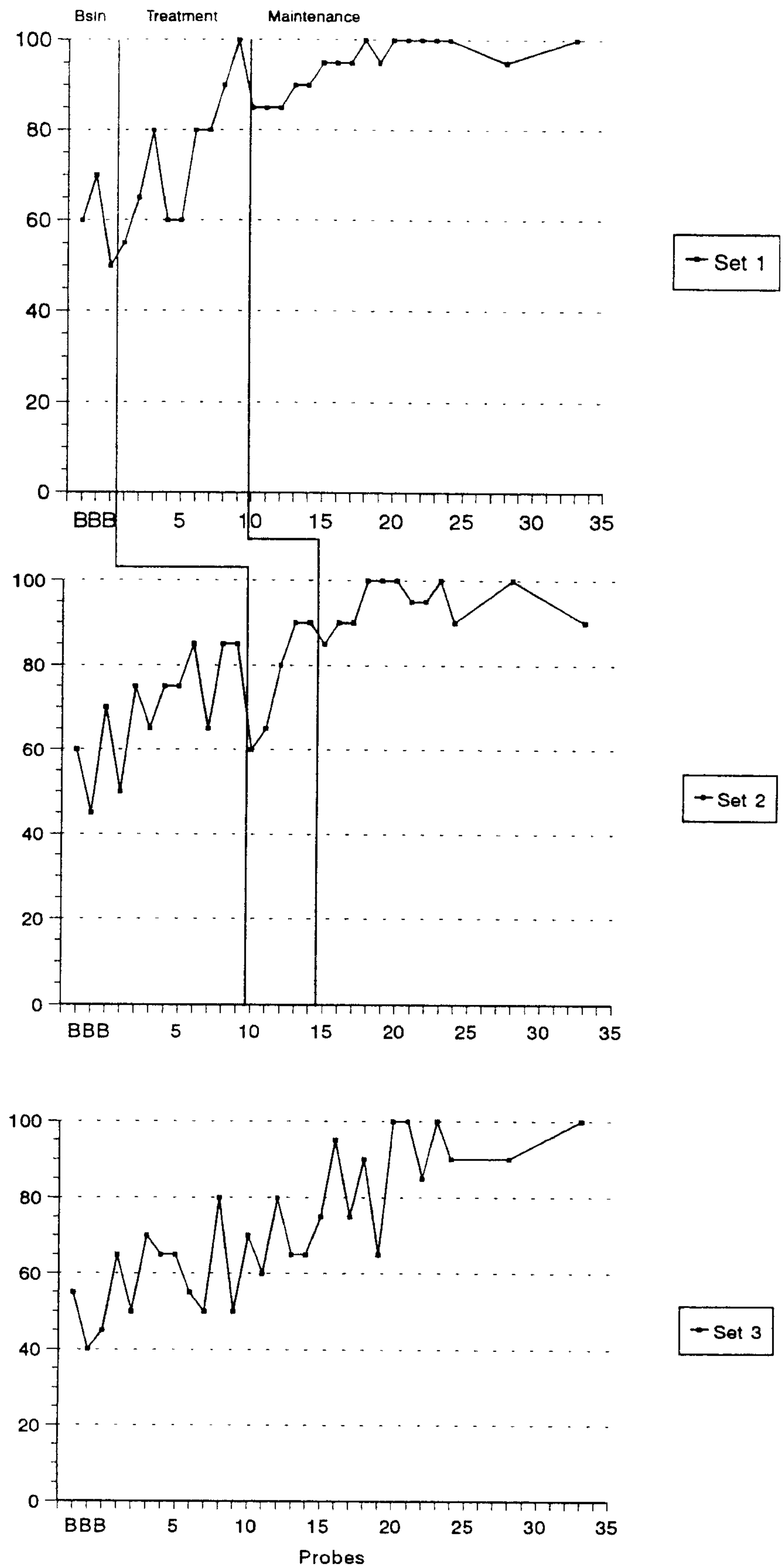

Figure 6. Percentage of correct oral reading of training and generalization items across all phases of the study.

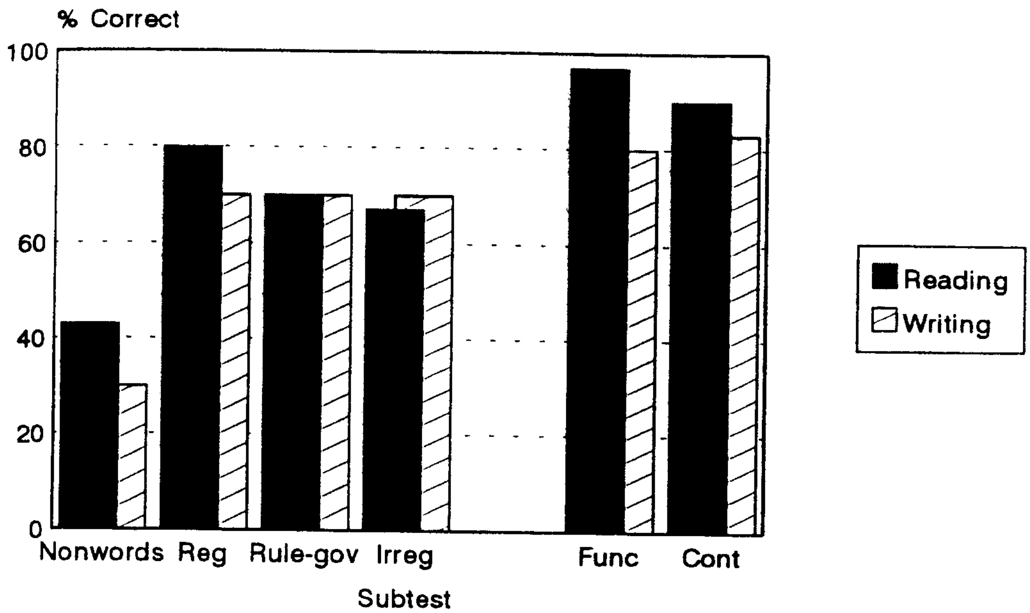

Figure 7. Postexperimental scores for selected reading and writing subtests of the Battery of Adult Reading Function (Reg = Regular words; Rule gov = Rule governed words; Irreg = Irregular words; Func = Functor words; Cont = Content words).

Postexperimental reading scores on the BARF improved substantially, equaling or exceeding the scores obtained for writing (Figure 7). While improvement was observed for writing scores, the magnitude of change for writing was substantially less than that observed for reading.

Oral reading errors, while reduced, continued to be of the phonologic type (Figure 8). Neologistic errors generally were absent, except for one occurrence during oral reading of nonwords. The latter results are consistent with improved phonologic output planning.

Postexperimental results obtained on the WAB support the conclusion of improved phonologic output, with the most impressive changes occurring in the areas of repetition and naming (see Figure 2).

DISCUSSION

Based upon neuropsychological modeling, the subject's improved phonological output during reading could have been attributable to the use of letter identities which either combined to produce the target pronunciations or activated the orthographic forms of words that then activated the phonological forms of words. Alternatively, improved phonological

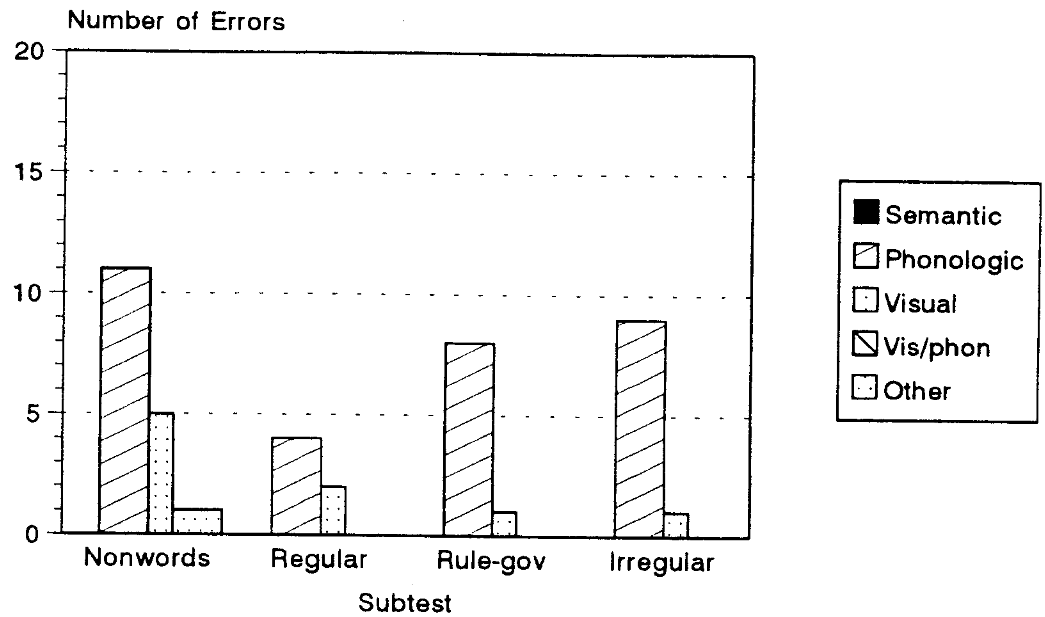

Figure 8. Postexperimental distribution of error types by reading subtest of the Battery of Adult Reading Function.

output may have been the result of access to the phonological information associated with the word meanings activated by the orthographic forms of the words. Evidence supplied by the treatment findings suggests that the subject's output during reading prior to intervention improved as a result of access to the phonological information associated with the word meanings. This will be elaborated upon later.

The treatment reported here utilized the subject's relatively preserved, and even preferred, orthography to improve her phonological output planning. Writing words that she could not orally produce accurately may have provided an effective means for activating the phonological units associated with these words. This technique presumedly enabled her to access the lexical phonology of these words from their lexical orthography (Caplan, 1993). For those items that continued to present her difficulty even after writing them, pairing the target phoneme with the same phoneme in a key word provided a cue that was apparently effective in activating the sublexical phonology corresponding to these sublexical orthographic units. Accurate oral word production could then be observed which was unattainable using whole word orthography only. When these cuing methods were unsuccessful, simple word repetition seemed to benefit the subject by providing a direct auditory model of the phonological forms of these words.

From a syndrome perspective, this subject would have been classified initially as demonstrating Wernicke aphasia and subsequently, conduction aphasia. Damasio and Damasio (1980) reported that the typical lesion associated with conduction aphasia involves portions of the left auditory complex, arcuate fasciculus, insula, and supramarginal gyrus. The arcuate fasciculus originates in the cortex of the supratemporal plane, arches around the back end of the sylvian fissure, and courses in the superior longitudinal fasciculus through the parietal operculum over the extreme capsule and insula to reach the lower frontal region (Damasio and Damasio, 1980). The subject's cortical lesion within the left insula and posterior parietal operculum was the result of infarction to the posterior parietal branch of the middle cerebral artery and is consistent with the description of the lesion causing conduction aphasia. In addition, based on the anatomy described above, there is strong evidence to suggest additional involvement of the arcuate fasciculus. The lesion pattern, therefore, can account for the initial aural comprehension impairment of this subject with later recovery to a mild condition and continuous disruption of speech output. The aphasia recovery pattern is also consistent with conduction aphasia—many of these subjects evolve from an earlier picture of Wernicke aphasia. However, unlike most individuals with conduction aphasia, this subject demonstrated a significant impairment to "meaningful speech" (Damasio and Damasio, 1980) and a large discrepancy between her spoken and written output.

An experimental issue relating to the efficacy of the treatment approach concerns what might be interpreted as a loss of experimental control during the baselining phase for the second stimulus set. The unstable baseline and the generalized improvement across both the treated and untreated stimuli when the treatment was applied to the first set only might suggest that an improvement trend was already present. Alternatively, it might suggest that a more general source than from the treatment itself, e.g., spontaneous recovery, exposure effects.

Alternatively, it should be noted that a high degree of reading accuracy could be attained for these simple bisyllabic words by increasingly employing a semantically versus phonologically based approach during repeated exposures to these stimuli. Unfortunately, the design employed here does not allow a direct test of the approach utilized by this subject. However, if the subject was employing a semantic strategy, as suggested previously, a treatment emphasizing the phonology of the letter identities would be expected to disrupt performance and cause it to decrease dramatically. This is, in fact, what was observed when the second set of stimuli was introduced and the subject's performance returned to baseline levels. What appears to be a loss of experimental control, therefore, may actually provide support for the subject's increasing preference for a semantic strategy. The regression in performance at the point where treatment was applied to set 2 and the subsequent improvement in oral reading performance does seem to suggest that the treatment stimulated phonological processing effectively. Conclusive statements regarding the efficacy of this treatment will have to await replication with more stable baseline data. It is interesting to note that following treatment, this subject consistently said the name of the first letter of a failed word to assist her in pronouncing the word. This strategy had not been observed prior to the initiation of treatment.

Finally, it bears repeating that the subject was treated for improved auditory comprehension, naming, and sentence formulation concurrent with the phonological treatment reported here. While the nature of the tasks used to treat these areas was sufficiently different so that a substantial effect on the experimental outcomes would not be expected, nonetheless, future studies should evaluate the effects of phonological treatment without concurrent treatment for other language areas.

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