Efficacy of the PROMPT System of Therapy for the Treatment of Acquired Apraxia of Speech: A Follow-up Investigation

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Our purpose is to report the results of administration of the PROMPT System of Therapy (Chumpelik, 1984) to three patients with chronic apraxia of speech and aphasia. Last year at this Conference, we presented data which indicated that one patient with severe apraxia of speech and Broca's aphasia demonstrated accelerated learning curves for the production of minimally contrastive words (e.g. miss-mit) and functional phrases (e.g., "What time is it?"). Significantly improved intelligibility scores as measured by the AIDS (Assessment of Intelligibility of Dysarthric Speech, Yorkston and Beukelman, 1981) also were demonstrated. Decreased performances on all measures occurred subsequent to the withdrawal of therapy. The purpose of the present study was to determine whether the application of PROMPTs enhanced accuracy of motor speech production on various types of target stimuli.

The PROMPT System. The PROMPT System or "Prompts for Restructuring Oral Muscular Phonetic Targets" (Chumpelik, 1984), is a dynamic tactile and kinesthetic-based articulatory-prosodic treatment strategy for the enhancement of motor speech production. Although based upon principles of motokinesthetic therapy (Stichfield and Hawk-Young, 1938), PROMPTs affords more than place of production, voicing, oral-nasal and transitional cues. It provides patients with multiple simultaneous cues concerning the production of each segment. These multiple cues include place of production, voicing, orality-nasality, degree of jaw opening, manner of production, phoneme duration, and tense-lax muscular contraction cues. As well, the temporal delivery of PROMPTs is thought to enhance coarticulation and transitionalization as well as establishing rate control. PROMPT therapy previously has been demonstrated to be efficacious for the treatment of developmental apraxia of speech (Chumpelik and Sherman, forthcoming) and in the treatment of one chronic Broca's aphasic individual (Square, Chumpelik and Adams, 1985).

METHOD

Subjects. The subjects of the current investigation were three patients who demonstrated at least 9 of the 14 symptoms (Dabul, 1979) of apraxia of speech as derived from administration of the Apraxia of Speech Battery for Adults (Dabul, 1979) and the Mayo Clinic Screening Battery for Apraxia of Speech. Their apractic symptoms are summarized in Table 1. All subjects were classified as Broca's aphasic patients on the Western Aphasia Battery (Kertesz, 1982). Each was at least one year post onset, severely limited with regard to functional verbal expression, and discharged from formal speech and language therapy because of lack of progress.

Table 1. Characteristics of apraxia of speech of speech demonstrated by each patient.

Speech Characteristic	Patient PW	RJ	SS
Phonemic Anticipatory Errors			
Phonemic Perseverative Errors	X		X
Phonemic Transposition Errors			
Phonemic Voicing Errors	X	X	X
Phonemic Vowel Errors	X	X	X
Visible/Audible Searching	X	X	X
Numerous/Varied Off-Target	X	X	X
Errors Highly Inconsistent	X	X	X
Errors Increase with Length	X	X	X
Fewer Errors in Automatic Speech	X	X	X
Marked Difficulty Initiating		X	X
Intrusive Schwas, CCs		X	
Abnormal Prosody			
Awareness of Errors/Inability to Correct	X	X	X

Procedures. Performances of each subject were baselined over three consecutive days on production of 24 pairs of minimally contrastive phonemes given three times (total of 9 productions for each pair and 222 total productions), 10 bisyllabic words given 10 times each (total of 90 productions of each word) and 9 functional phrases (total of 90 productions of each phrase). Production of all stimuli were scored as correct or incorrect by the two clinicians. A third investigator who had not observed the patients' performances selected the stimuli for the investigation based upon the scored data. For each patient, four pairs of minimally contrasting phonemes were selected which had never been produced correctly. Two pairs were randomly selected for training using PROMPTs and two pairs acted as controls for probing imitation. For two subjects, four polysyllabic words were randomly selected--two for training using PROMPTs and two for probing. For the third subject, six polysyllabic words were selected--three for training and three for probing. For two subjects, functional phrases were trained. For one subject, two phrases were trained and two were probed. For the other subject, one phrase was trained and a second was not.

A scoring system of either totally correct or incorrect was applied. For phrases only, each word produced correctly received one point. Point-to-point interrater reliability using the correct-incorrect system was found to range from 86 to 95%. Mean reliability was 91%. Intrarater reliability using the latter scoring system was previously found to be .90 (Chumpelik and Sherman, forthcoming).

The PROMPT training procedure was as follows. First, the patient was presented with an auditory model of a minimal pair, word or functional phrase. No prompts were given. The patient attempted to repeat the target according to a model. If the response was correct, the next trial was

presented for a total of 20 (20 tokens presented). If however, the response was incorrect, the clinician prompted as follows: the subject was instructed not to respond as the clinician "mapped in" the correct motor pattern for the sequence of phonemes to be produced using the PROMPT System. The clinician then instructed the subject to attempt target phoneme, word or phrase as the clinician simultaneously PROMPTed the motor pattern again. The response was scored preceded by a "P" for "Prompt." The next token in each train of 20 was then presented auditorally for imitation and the same procedure was followed based upon the subject's ability to imitate the token.

RESULTS

Minimal Pairs. The percent correct productions for the minimal phoneme pairs for each subject are summarized in Table 2. Subject PW demonstrated accelerated learning curves for the phoneme contrasts which were trained using PROMPTs. Eighty percent accuracy of production for d/z was achieved by session 3 and maintained throughout the experimental period (i.e., up to and including session 12). For tʃ/ʃ, 90% accuracy of production was achieved by session 9 and maintained. Accuracy of production of the untrained pairs, f/v and t/k remained at 0%.

TABLE 2. Percent of trained and untrained phoneme contrasts accurately produced by each subject.

	SUBJECT											
	1 P.W.				2 R.J.				3 S.S.			
	Trained		Untrained		Trained		Untrained		Trained		Untrained	
Session	d/z	tʃ/ʃ	f/v	t/k	t/k	f/v	tʃ/ʃ	d/z	t/n	v/f	d/z	tʃ/ʃ
1	75	5	0	0	45	0	0	0	75	55	0	0
2	35	20	0	0	30	65	5	0	80	65	0	0
3	80	65	0	0	75	15	15	0	85	85	5	0
4	100	65	0	0	90	65	10	0	90	85	40	0
5	100	70	0	0	85	75	0	0	90	80	40	0
6	100	75	0	0	85	80	5	0	90	90	65	0
7	100	80	0	0	100	80	0	50	100	95	40	0
8	100	50	0	0	100	80	5	5	95	90	60	15
9	85	95	0	0	95	85	0	5	95	100	80	0
10	100	95	0	0	90	90	0	0	100	90	85	0
11	95	95	0	0	--	--	--	--	100	95	70	5
12	100	95	0	0	--	--	--	--	100	100	90	0

Subject RJ achieved 90% accuracy on the trained pair t/k by session 4 and maintained performances above 85% throughout the investigation (i.e., up to and including session 10). For the second trained pair, f/v, 80% accuracy of production by session 6 was attained and maintained.

For the untrained pairs, tʃ/ʃ and d/z, accuracy of production did not exceed 15% for the former and 50% for the latter. In the case of d/z, accuracy of production remained at 0% through session 6, sporadically reached 50% in session 7 and then diminished to 5 and 0% for the remainder of the experimental period.

Subject SS achieved 80% accuracy of production of the trained pair t/n by session 2 and 85% accuracy of the trained pair v/f by session 3. These performances were maintained and improved upon throughout the investigation, up to and including session 12. For the untrained pair, t∫/∫ , daily performances hovered around 0% with the exception of session 8, in which 15% accuracy was achieved. For the second untrained pair, d/z, a slowly accelerated and variable learning curve was demonstrated. SS finally attained 80% accuracy of production by session 9, 85% for session 10, 70% for session 11 and 90% for session 12. This learning was thought to occur because the phonetic features of alveolar place of production and voicing contrasts were taught in the trained (prompted) pairs, t/n and v/f, respectively.

Polysyllabic Word Production. The percent correct production data for the polysyllabic words for each subject are summarized in Table 3. Subject PW attained 80% accuracy of production for the trained word "cabinet," and 95% accuracy of production for the trained word "sensation" by session 5. Level of accuracy of production was maintained above criterion level of 80% throughout the remainder of the experimental period with one exception. During session 8, accuracy of production of "cabinet" dropped to 60%. The untrained items, "tobacco" and "father," were produced with 0% accuracy over all twelve sessions.

TABLE 3. Percent of trained and untrained polysyllabic words accurately produced by each subject.

	SUBJECT													
	1 P.W.				2 R.J.				3 S.S.					
	Trained		Untrained		Trained		Untrained		Trained			Untrained		
Session	cabinet	sensation	tobacco	father	tobacco	scissor	canteloupe	father	decorate	chiffon	fanciful	canteloupe	seafood	sensation
1	15	10	0	0	0	0	0	0	0	10	0	0	0	0
2	40	0	0	0	5	0	0	0	15	65	45	0	0	5
3	50	40	0	0	15	25	0	0	30	85	55	0	0	0
4	70	75	0	0	70	55	0	0	45	85	60	0	0	0
5	80	95	0	0	85	85	0	0	95	85	95	0	0	0
6	85	80	0	0	95	85	0	0	85	90	80	0	0	5
7	100	98	0	0	95	85	0	15	95	95	85	0	0	0
8	60	100	0	0	100	100	0	10	95	100	85	0	0	20
9	88	100	0	0	95	100	0	25	90	90	75	0	0	10
10	95	100	0	0	95	95	0	25	100	80	85	0	0	5
11	100	100	0	0	--	--	--	--	95	80	100	0	0	25
12	95	100	0	0	--	--	--	--	85	75	90	0	0	20

Subject RJ attained 85% accuracy of production of the two trained polysyllabic words "tobacco" and "scissor" by session 5. This level of accuracy of production was maintained and improved upon throughout the entire experimental period. For the untrained word "canteloupe" level of accuracy of production did not vary from 0% throughout the experimental period. For the untrained word "father" 0% accuracy of production was maintained through session 6. Minimal improvement was noted during session 7 in which 15% accuracy of production was achieved. This dropped to 10% during session 8 and improved to 25% in session 9 and maintained at this level for session 10.

Subject SS was trained on three and baseline was measured on three polysyllabic words. The trained words included "decorate," "chiffon," and "fanciful." By session 5, 95% accuracy of production was achieved for the words "decorate" and "fanciful." Accuracy of production was maintained at or above the criterion level of 80% for each for the remaining sessions of the experimental period. For the third trained word, "chiffon," 85% accuracy of production was maintained for the remainder of the experimental period, with the exception of session 12, in which production decreased to 75% accuracy.

Functional Phrases. Only for subjects PW and RJ were functional phrases trained and probed. Subject SS, who was six years post onset, attained baseline scores which hovered between 15% and 60% accuracy for phrase production. She appeared to have learned the strategy of syllable-by-syllable production in order to attain correct production of phrases. Since each word was scored in a phrase and a mean percent correct was derived for each, correct production of just one word in a four word phrase resulted in a score of 25% accuracy. Since subject SS often attained this level of success due apparently to compensatory strategies, she was not trained on phrases.

The accuracy of production data for subject PW and subject RJ on phrases is summarized in Table 4. For subject PW, on the trained (prompted) phrase, "Help me.", 90% accuracy of production was achieved by session 2 and improved upon until the attainment of 100% accuracy during session 4. This level of accuracy of production was maintained throughout the remainder of the experimental period. For the trained phrase, "How are you?" 95% accuracy of production was attained by session 3 and maintained above the 92% level for the remainder of the experimental period. PW's accuracy of production of the untrained phrase, "Stop it." hovered around 0% with a sporadic attainment of 43% accuracy during session 5. For the untrained phrase, "Give it to me." accuracy of production hovered around 25% from session 4 to the termination of the experimental period (session 12).

TABLE 4. Percent of trained and untrained phrases accurately produced by each subject.

	SUBJECT 1 P.W.				SUBJECT 2 R.J.	
	Trained		Untrained		Trained	Untrained
Session	Help me.	How are you?	Stop it.	Give it to me.	What do you want?	Stop it.
1	78	08	0	18	04	01
2	90	68	0	15	46	08
3	95	95	10	18	66	0
4	100	95	0	25	86	10
5	100	100	43	28	92	25
6	100	92	5	30	90	25
7	100	100	25	25	90	15
8	100	100	20	25	97	05
9	100	100	0	25	98	03
10	100	100	10	26	98	10
11	100	100	0	25	--	--
12	100	100	15	25	--	--

Subject RJ was trained on one phrase and probed on another. The longer phrase was purposefully selected as the trained phrase since it is known that aphasic individuals with apraxia have more difficulty producing longer phrases. By session 4, the trained phrase, "What do you want?" was produced with 86% accuracy. This level of accuracy was improved upon throughout the remainder of the experimental period. The untrained phrase, "Stop it." was never produced with an accuracy which exceeded 25%. In fact, accuracy of production hovered between 0 and 15% during the experimental period.

DISCUSSION

Administration of PROMPT therapy was found to be highly efficacious for all three subjects involved in this study as well as for the subject presented last year at this conference (Square et al., 1985). For subject PW, little or no improvement of phoneme contrasts and polysyllabic word stimuli occurred for untrained items. Some minimal yet variable improvement was demonstrated for several words in untrained phrases. For the other two chronic subjects of this study, PROMPT therapy resulted in rapidly accelerated and stable performance curves for all trained items.

Future research regarding PROMPT therapy will address several issues. These will include the application of alternating treatment designs in which the effects of repetition, rhythmic timing (buccal tapping), phonetic placement and PROMPTs will be investigated as applied to the learning of functional phrases in chronic apractic-aphasic patients whose verbal output is limited. Such studies will be undertaken in order to determine what aspect(s) of PROMPT treatment account for its effectiveness. That is, is it the rhythmic delivery, cues for spatial targeting, or the simultaneous delivery of these subcomponents which contribute to the effectiveness of PROMPTs? Also, the rate of learning afforded by repetition versus PROMPT will be studied. Future studies also will use environmental probes in order to determine whether the phrases acquired in PROMPT treatment generalize to and are used functionally in the daily lives of our patients.

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Performance of Aphasic Listeners on an Expanded Revised Token Test Subtest Presented Verbally and Nonverbally

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Although a complete understanding of aphasia remains elusive, the behavioral characteristics of the disorder are well documented. Notable among them is the high degree of variability shown by aphasic persons. McNeil (1982) noted that variability can occur over various temporal measures such as second to second or morning to afternoon. He also suggested that aphasic behavior can be variable across repeated trials of the same unit or across different items which are equally difficult. McNeil contended that analysis of the variability in aphasic persons' performance could provide information on the loss-versus-interference issue in aphasia. McNeil (1983) suggested that internal state factors (ISF) (as yet unidentified biological fluctuations within the individual) cause intact knowledge to be inaccessible to the individual. He proposed mathematical formulae for determining the amount of deficit attributable to performance factors as opposed to loss of competence. These mathematical procedures allow us to determine the percentage of deficit that represents the difference between what the subject has shown he or she can do compared to what he or she typically does. He stressed the importance of measuring variability of performance across several items of equal difficulty. The Revised Token Test (RTT--McNeil and Prescott, 1978) allows researchers to examine variability because it is a reliable instrument, sensitive to small changes in performance and has subtests consisting of several homogeneous items.

Brookshire (1974) described five types of auditory deficit patterns. They were: slow rise time, noise build-up, retention deficit, information capacity deficit, and intermittent auditory imperception. Since then other patterns have been proposed including tuning-in, tuning-out, and flat (McNeil and Hageman, 1979). A number of investigations have examined these patterns (Hageman, 1980; Hageman and Lewis, 1983; Hageman, McNeil, Rucci-Zimmer and Cariski, 1982; McNeil and Hageman, 1979). The only pattern to be observed consistently across items within subtests has been the intermittent pattern.

Another important aspect of processing impairment in aphasic persons is increased processing time. The RTT attempts to capture this aspect of performance by scoring delays. In addition, the RRT captures another temporal behavior indicative of poor processing termed immediacy which means responding too soon, before the message is complete. Since the RTT requires stimulus detection, stimulus recognition and execution of an appropriate motor response, the RTT could be considered as a choice reaction time task. Celebi (1978) observed that, despite numerous attempts to identify the source of reaction time variability, "the statistical distribution of RT values seems to have received little attention" (p. 355).

One purpose of this investigation was to examine the auditory comprehension and visual imitative abilities of aphasic listeners with respect to patterns of performance and accuracy of performance. A second purpose was to examine the response time variability of aphasic listeners across equally difficult items. A third purpose was to determine the amount of deficit that could be attributed to internal state factors.

METHOD

Seven aphasic individuals comprised the sample group (Table 1). The subjects were selected on the basis of their medical diagnosis and their performance on a standard administration of the RTT. The subjects were heterogeneous with respect to age, sex, time post-onset, etiology, site of lesion and severity. Each subject passed the RTT pretest and no subject required a repeat or cue on more than two of the items in RTT subtest IV.

Table 1. Descriptive data for subjects.

	Subjects						
	A	B	C	D	E	F	G
Sex	M	F	M	M	F	M	M
Age	69	55	58	55	83	54	74
Type of Behavior*	ex/re	ex	ex/re	ex/re	ex	ex	ex/re
Months Post-Onset	24	24	36	12	24	60	2

*ex = expressive; re = receptive

Each subtest of the RTT contains 10 items of equal difficulty. Each item contains eight elements which are individually scored. A mean item score is obtained from the eight elements and the subtest mean score is a mean of the item scores. For this expriment, the 10 command items of RTT subtest IV were used to generate the stimulus items. A trained examiner produced the 10 commands which were recorded in a sound treated room using a Teac tape recorder. Each of the 10 commands was copied 10 times, in random order, onto another tape which then contained 100 stimulus items thus becoming the Expanded Auditory Test (EAT). A twelve-second interstimulus interval was maintained. Since response time measures were to be obtained, it was necessary to determine the length of each command. The length of each command was determined by spectrographic analysis using the Kay Elemetric Sona-Graph, model 6061A.

The response time data were collected using a specially constructed wooden frame with a plywood bottom. A plexiglass cover was mounted within the frame on a pivot at midline with two microswitches positioned under the plexiglass to regulate time onset and offset. During the auditory task, the headphone output of the tape recorder was routed to a Hunter voice-activated relay (model 320S) which started the timing instrument (Lafayette clock/counter). The timer continued until the subject touched the first token (the tokens were placed on the plexiglass) which activated the microswitch, stopping the timer. During the interstimulus interval the examiner scored the subject's response using the standard RTT scoring procedure. An assistant recorded the raw response time data and reset the timer.

The same 100 items were presented to each subject as a nonverbal (non-auditory) task, the Expanded Visual Test. The subjects were instructed to watch the examiner and then touch the same tokens. The examiner listened to the test tape and touched the tokens as they were presented, which maintained a presentation rate equal to the auditory task. When the examiner touched the second token, the timer was activated. The subject stopped the timer by touching the first token. The subject's performance was scored in the standard manner by the examiner and an assistant recorded the response time and reset the timer.

Descriptive and quantitative analyses of the patterns generated by the subject's RTT item scores were completed following McNeil and Hageman's (1979) guidelines. For response time data, successive items having response times greater than plus/minus one standard error of measurement were considered meaningfully different. Computation of ISF values were based on McNeil's (1982) mean method. A one-way analysis of variance for repeated measures (Steinmetz, Romano, and Patterson, 1981) was computed when appropriate and the Tukey test for multiple comparisons (Hopkins and Glass, 1978) was used to test for specific differences.

RESULTS

First, a quantitative analysis of the subjects' performance was completed. This analysis tested the quantitative performance of the subjects on the auditory task compared with the visual task. In addition, the quantitative performance of the subjects at the beginning of the auditory tasks was compared with their quantitative performance at the end. Thus, mean scores were examined for significant differences across the standard RTT subtest IV, the expanded auditory test (EAT), the first 50 items of the EAT, the last 50 items of the EAT, the first 10 items of the EAT, the last ten items of the EAT and the expanded visual test (EVT). The mean scores are shown in Table 2.

The analysis of variance procedure (Table 3) and the Tukey Test for multiple comparisons revealed that the mean scores in one comparison differed significantly. The expanded auditory test mean scores were significantly ($p < .05$) lower than the scores on the EVT. The RTT mean scores for the standard, the EAT, the first 10 items from the EAT, and the last 10 items of the EAT were not significantly different. The visual presentation was significantly easier than the listening task for these aphasic subjects to complete ($p < .05$). There was no evidence to suggest that these aphasic listeners performed quantitatively differently from the beginning to the end of the EAT.

Second, the patterns of across item-within subtest performance that developed were of interest. With respect to the RTT scores, the only across item-within subtest pattern which occurred for the auditory tasks (both the standard RTT and the EAT version) was the intermittent pattern. This pattern was confirmed by the quantitative analysis reported above, in which no significant differences in performance were observed from the beginning to the end of the EAT. However, a pattern analysis of the RTT scores for the EVT showed that 43 percent showed a flat pattern and 29 percent demonstrated a tuning-in pattern. When the response time data are examined, the only pattern that emerges is intermittent. This was true for the EAT and EVT for every subject.

Table 2. Mean values by subject for each variable within the auditory and visual-manual presentations.

	Subjects							
	A	B	C	D	E	F	G	Mean
Auditory								
Entire standard RTT	13.21	14.01	14.39	12.46	12.42	13.21	11.58	13.04
Standard subtest IV	12.90	14.30	14.50	12.48	12.50	12.73	11.51	12.99
Total expanded test	14.57	14.80	14.44	11.83	11.95	13.81	11.66	13.29
First 50 items	14.47	14.73	14.54	11.87	11.90	13.92	11.77	13.31
Last 50 items	14.66	14.87	14.34	11.80	12.01	13.70	11.54	13.27
First 10 items	14.33	14.63	14.60	12.16	12.51	13.45	11.89	13.37
Last 10 items	14.90	15.00	14.28	11.62	11.25	13.63	11.73	13.20
Visual-manual								
Total expanded test	14.69	15.00	14.99	14.97	15.00	14.98	14.85	14.93

Table 3. One-way analysis of variance with fixed effects: Standard and modified versions of RTT Subtest IV.

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F-ratio
Source	Sum of Squares	Degrees of Freedom	Mean Squares	F-ratio
Between	16.996	4	4.249	2.944*
Within	43.303	30	1.443	

*significant $p < .05$.

Table 4 shows the internal state factor (ISF) values obtained for all measures. In all cases, ISF was greater than 99 percent and was actually 100 percent in 18 of 21 possible occurrences.

An analysis of variance (Table 5) showed that the ISF values were not significantly different across tests. The ISF values were the same for both tasks even though the EAT was significantly more difficult than the EVT.

Table 4. ISF values (percents) for Subtest IV and the expanded RTT in its auditory and visual-manual presentations.

	Subjects						
ISF Values	A	B	C	D	E	F	G
Subtest IV	100%	100%	100%	99.7%	100%	100%	99.7%
Expanded auditory	100%	100%	100%	100%	100%	100%	99.8%
Expanded visul-manual	100%	100%	100%	100%	100%	100%	100%

Table 5. One-way analysis of variance with fixed effects: ISF comparisons.

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F-ratio
Between	.026	2	.013	1.534*
Within	.153	18	.0085	

*Not significant $p > .05$.

DISCUSSION

McNeil and Hageman (1979) had hypothesized that four across item-within subtest patterns could occur. The results of this study suggest that when the task is reasonably difficult the only across item-within subtest pattern is intermittent. The presence of what appear to be other patterns of auditory processing may actually be artifacts of the number of items presented or the length of the time period sampled. This investigation is particularly relevant to the issue of fatigue or tuning-out as a pattern of behavior. These subjects performed a task that held difficulty constant across 100 items. There was no significant difference in performance from the beginning to the end of the test. Thus, it would appear that tuning-out does not occur, at least not over a reasonable number of items (100) or over about 30 minutes. The tuning-in pattern did not occur either. Subjects did not profit from repeated trials of RTT commands, suggesting that one cannot learn to take the RTT or that aphasic listeners cannot adjust their effort allocation to perform better.

The occurrence of the tuning-in and flat patterns on the visual task was due to the low level of difficulty combined with a scoring system that is not sensitive to extremely small variations in performance. The pattern presented by this measure could best be described as intermittent.

The subjects performed significantly better on the visual task compared with the auditory task. Short-term memory is one cognitive process that is involved in the execution of these tasks. Crowder (1972) suggested that acoustic storage (echo) lasts two to four seconds while the visual storage (iconic) lasts one fourth of a second because "in vision ... the human being can often arrange for the persistence of the stimulus itself without need of a persistent stimulus trace." (p. 256). The visual task in this study was such that the subjects could continue to view the tokens. Consequently, encoding in visual short-term memory may not have been required and the command items may have been processed as two rather than eight units.

The ISF values (over 99%) support the contention that errors were not made because of inability to perform the tasks but because of inability to do so all of the time. The high ISF values lend support to McNeil's (1982) premise that aphasia is a phenomenon of interference, not loss. Had a loss of competence been operating, one would have expected lower ISF values.

McNeil (1984) suggested that an internally generated oscillator may be contributing to fluctuations in performance in aphasia. The length of the EAT allowed us to examine this issue at a behavioral level. The item mean scores for each subject were converted into z scores. The location in time of z scores more negative than minus one were noted. When this was done, we observed that over 50% of the scores that were more negative than minus one were adjacent in time or occurred within an item. While this clustering of deviant scores is not sufficient evidence to refute or support the cyclical nature of performance in aphasia, it certainly provides a point of reference for future investigation.

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Preservation of Familiar Speaker Recognition but not Unfamiliar Speaker Discimination in Aphasic Patients

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Communication involves an exchange of different kinds of information. Besides linguistic content (structured into phonological, syntactic, and semantic systems), there is the important realm of paralinguistic information, which includes attitudes, affect, mood, and personal traits (sex, age, personality). Paralinguistic information, carried mainly in the prosodic material of speech (pitch, duration, loudness, voice quality) is not made up of discrete units as the linguistic system (phonemes and words) is, but instead, involves different characteristics altogether. Gradations and degrees occur in the case of emotions and attitudes, and unique patterns make up speaker identity.

As left hemisphere specialization for language is presumably accounted for and dependent upon the structural properties of linguistic systems, an interesting question arises about the hemispheric specialization for paralinguistic information in communication. Recent studies suggest that hemispheric specialization is related to the structural properties of the stimulus. For example, when prosodic contrasts constitute a linguistic tonal system, they are processed in the left hemisphere (Van Lancker and Fromkin, 1973, 1978; Gandour and Dardaranda, 1983). On the other hand, a right hemisphere specialization has been found for prosodic material signalling emotional content (Heilman, Scholes and Watson, 1975; Ross, 1981) and personal voice identity (Van Lancker and Canter, 1982) (Table 1).

Table 1. A model for hemispheric specialization.

	LEFT		YES	
	↑	Phonological (tones)	↑	
		Grammatical (word stress)		
HEMIS-		Grammatical (sentence intonation)		LINGUISTIC
PHERE		Attitudinal (disapproval, irony)		STRUCTURE
		Emotional (happy, sad)		
	↓	Voice information (sex, age, identity	↓	
	RIGHT		NO	

Thus although all this acoustic material is carried in speech, only part--the linguistic content--is processed in the left cerebral hemisphere, whereas paralinguistic information may be processed in the right.