Phonologic Priming and Picture Naming in Aphasic and Normal Subjects

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Anomia has typically been thought of as a unitary disorder. Recently, some investigators have proposed that anomic disorders may differ depending on the type of aphasia or the site of lesion (Benson, 1979, 1983; Geschwind, 1967; Lesser, 1987; Luria, 1972, 1977, 1980). Patients with lesions posterior to the Rolandic fissure are hypothesized to have "lexical-semantic" disruptions. Patients with anterior frontal lobe lesions are believed to have difficulty accessing these representations or actually producing the selected words.

Using a priming paradigm is one way to test whether the underlying lexical-semantic representation is intact without requiring a metalinguistic response. Priming occurs when two stimuli are presented consecutively and information extracted from the first (prime) stimulus modifies the time needed to process the second (target) stimulus. When the two stimuli are related, reaction times and error rates for judgments concerning the target stimulus decrease (Bowles & Poon, 1985; Marcel, 1983; Meyer & Schvaneveldt, 1971).

Several studies have applied the priming paradigm to lexical decision tasks with aphasic subjects (Gerratt & Jones, 1987; Katz, 1988; Milberg & Blumstein, 1981; Milberg, Blumstein, & Dworetsky, 1988). However, no studies have used a priming paradigm with naming responses. Aphasiologists do use cueing, a variant of priming, to facilitate naming performance in aphasia. Studies suggest that cues do improve naming performance of patients with anomia. However, the results conflict regarding which aphasic patients benefit most from therapist cueing or which cues are most effective. One relatively consistent finding is that Broca aphasic patients appear to benefit from initial phoneme or initial syllable cueing, while Wernicke aphasic patients do not (Goodglass & Stuss, 1979; Li & Canter, 1983; Love & Webb, 1977).

Much of speech-language therapy for anomia focuses on the clinician's attempts to find those cues or prompts that facilitate subsequent naming performance. The priming paradigm may provide the researcher and clinician with an objective way to determine whether specific linguistic stimuli facilitate oral picture naming performance. Therefore, this experiment addressed whether phonologic primes assist posterior and anterior aphasic patients similarly or differentially on oral picture naming tasks.

METHOD

Aphasic Subjects

Twenty aphasic subjects, eleven with anterior lesions and nine with posterior lesions, participated in the experiments. All aphasic subjects had sustained a single, left hemisphere, occlusive cerebrovascular accident. Lesion localization was ascertained by computerized tomography (CT). Anterior patients were those with lesions confined primarily to the frontal lobe. Posterior patients had lesions in the temporal and/or parietal lobes.

Aphasic subjects met criteria of being premorbidly right-handed, premorbidly literate, native American English speaking, with audiometric thresholds within normal limits for their ages in the speech frequencies (500, 1,000, and 2,000 Hz.). All aphasic subjects were evaluated on the Western Aphasia Battery (WAB) (Kertesz, 1982) to establish their aphasia classification. The Motor Speech Evaluation (Wertz, LaPointe, & Rosenbek, 1984) was administered to screen out those patients with severe apraxia of speech or dysarthria, problems which could preclude oral naming. All aphasic subjects scored within two standard deviations of the mean on the Children's Embedded Figures Test (Karp & Konstadt, 1971) to rule out visual deficits that might have impeded performance. Eighteen of the aphasic subjects had scores at least 2 standard deviations below the mean for normal controls on the Boston Naming Test (BNT) (Nicholas, Brookshire, MacLennan, Schumacher, & Porrazzo, 1989). The two remaining aphasic subjects were included because their naming scores were at least two standard deviations below the mean for the 12 control subjects described below. Descriptive data for the aphasic groups are provided in Table 1.

Normal Controls

The control group had no history of neurological illness or speech-language disorders. All 12 control subjects were right-handed, literate, native

TABLE 1. DEMOGRAPHIC INFORMATION AND SCREENING MEASURES FOR THE EXPERIMENTAL GROUPS

	Anterior Aphasic		*Posterior Aphasic*		*Controls*	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Age (years)	59.09	11.68	64.11	5.53	64.92	5.35
Education (years)	13.64	3.07	13.78	4.55	14.92	2.39
Aphasia Quotient (WAB)	85.15	6.07	79.94	13.84	99.57	.49
Boston Naming Test	37.73	10.03	32.11	16.44	56.33	2.42

American English speakers who had audiometric thresholds within normal limits for their ages in the speech frequencies. They all scored within the normal range on the WAB Aphasia Quotient (above 93.8), and within 1 standard deviation of the mean on the BNT. Descriptive data for the control group are included in Table 1.

Apparatus

Stimuli for all experiments were presented on a Macintosh SE microcomputer with a 20 megabyte internal hard disk using modified Apple HyperCard software. Bit mapped graphic representations of the line drawings were presented in the center of the Macintosh SE screen. Phonologic primes were produced by digitizing the experimenter's voice using MacRecorder hardware and software. Naming responses were timed by the microcomputer by using an adapted MacRecorder as a voice-actuated switch.

Stimulus Materials

The picture stimuli consisted of black and white line drawings from the Snodgrass and Vanderwart set (1980). We selected 60 pictures for our study. Target pictures were randomly given valid, invalid, or neutral primes with a total of 60 test trials, 20 with validly primed picture targets, 20 with invalidly primed picture targets, 20 trials with neutral primes. Twenty target pictures were primed by a valid, phonologically related sound that was always the first sound(s) of the target picture (e.g. /bai/ priming a picture of a bicycle). These valid primes were the initial "syllable" of the target picture—the first consonant-vowel pair, consonant cluster, or initial vowel of the target. The 20 invalid primes had no relation to their subsequent targets (e.g., /fu/ priming a picture of a bed). The 20 neutral primes were 1,000 Hz tones.

Procedure

Subjects completed the experiment in one session, lasting approximately 15 to 20 minutes. The present experiment was one in a series of three priming experiments that subjects completed in one day. Subjects were seated in front of the microcomputer and informed that a sound would be heard, followed by a picture on the computer screen. The subject was asked to name the picture as quickly and as accurately as possible. Once a trial was initiated, the sound (prime) was presented, followed for 500 milliseconds by a blank screen and, thereafter, the target picture. The target picture remained in view until the subject provided a verbal response, triggering the voice-actuated relay or until 30 seconds had elapsed. The computer stored the subject's vocalized response time (RT) and experimenter coding. Then the screen was cleared and the next sequence began.

Statistical Analysis

Response latencies to correct responses as well as the number of errors were the dependent measures. Median RTs were computed for each subject's response to valid, invalid, and neutral prime-target pairs, excluding incorrect responses. Subjects who produced at least two correct responses in each prime-target condition were entered into this analysis. In the analysis of naming accuracy, the percentage of correct responses for all subjects in each condition was computed. Due to the lack of heterogeneity of the variance among the anterior aphasic, posterior aphasic, and control groups, prime-target pairs were submitted to three separate ANOVAs, one for each group. Significance level was set at .05.

RESULTS

Table 2 summarizes group means and standard deviations for response times and accuracy.

Anterior Aphasic Group

Response Time. The main effect for type of prime was not significant ($F[2,16] = 2.128$, $p = .150$). Across subjects, median response times were 1,122 milliseconds in the valid condition, 1,224 milliseconds in the invalid

TABLE 2. MEANS OF MEDIAN RESPONSE TIMES AND ACCURACY RATES FOR VALID, NEUTRAL, AND INVALID PRIMES IN THE ANTERIOR APHASIC, POSTERIOR APHASIC, AND CONTROL GROUPS

Group	*Valid*	*Neutral*	*Invalid*
Anterior Aphasic Subjects			
Response Time	1122 (145)*	1095 (153)	1224 (264)
Accuracy Rate	70%	65%	42%
Posterior Aphasic Subjects			
Response Time	1226 (369)	1366 (325)	1434 (414)
Accuracy Rate	53%	48%	39%
Control Subjects			
Response Time	782 (94)	848 (122)	912 (120)
Accuracy Rate	74%	74%	60%

*Response times are in milliseconds; standard deviations are in parentheses.

condition, and 1,095 milliseconds in the neutral condition. These data indicate that subjects had the fastest response latencies in the neutral prime-target condition (although not statistically significant); thus, the neutral prime did not function as such. Jonides and Mack (1984) contended that a neutral control condition that uses the same stimulus on all trials, like the control employed here, may underestimate priming effects because the neutral control prime may require less encoding than the valid or invalid primes. Therefore, some may prefer to refer to the neutral primes in the present experiment as "alerting" stimuli.

Accuracy Data. A robust main effect for prime type was evident ($F[2,20] = 21.003$, $p < .001$) Unlike the RT data, the valid condition produced the best performance. A Tukey analysis of paired comparisons indicated that validly primed targets (phonologically related) were named more accurately than invalidly primed targets, and targets with neutral primes were named more accurately than targets with invalid primes (Tukey $.05[3,20] = 11.413$). Overall accuracy was 70% for validly primed targets, 42% for invalidly primed targets, and 65% for targets preceded by neutral primes.

Posterior Aphasic Group

Response Time. The main effect for prime type was significant for the posterior aphasic group ($F[2,14] = 4.108$, $p = .039$). Median response times were 1,226 milliseconds in the valid condition, 1,434 milliseconds in the invalid condition, and 1,366 milliseconds in the neutral condition. One comparison was significant—validly primed targets were named faster than invalid targets (Tukey .05[3,14] = 193.189).

Accuracy Data. A main effect for prime type was evident ($F[2,16] = 7.277$, $p = .006$). Validly primed targets were named at higher accuracy than invalidly primed targets (Tukey .05[3,16] = 9.92). Accuracy was 53% for validly primed targets, 39% for invalidly primed targets, and 48% for picture targets with neutral primes.

Control Group

Response Time. The main effect for prime type was significant ($F[2,22] = 7.255$, $p = .004$). As with the anterior and posterior aphasic groups, phonologically related primes were named faster than unrelated primes. Median response times were 782 milliseconds in the valid condition, 912 milliseconds in the invalid condition, and 848 milliseconds in the neutral condition. Validly primed targets were named significantly faster than invalidly primed targets (Tukey .05[3,22] = 86.006).

Accuracy Data. Once again the main effect of prime type was significant ($F[2,22] = 6.679$, $p = .006$). Two comparisons were significant—targets with valid or neutral primes were named with higher accuracy than targets with invalid primes (Tukey .05[3,22] = 11.33). Valid and neutral prime types produced equivalent accuracy—74%. Invalidly primed targets were at 60% accuracy.

DISCUSSION

We intended to determine whether phonologic primes affected posterior and anterior aphasic patients similarly or differentially on oral naming tasks. These data indicate that, overall, the anterior and posterior aphasic patients performed similarly. A phonologic priming effect on accuracy was found in all three groups. Naming accuracy for valid primes was greater than or equal to that for neutral primes and lowest for invalid primes. A corresponding phonologic priming effect on response times was found in the posterior aphasic and control groups.

These findings, especially the phonologic priming effect found for posterior aphasic subjects, differ from the hypotheses and implications in current cueing literature, which suggests that posterior aphasic subjects do not typically respond to phonologic cueing. Why did they exhibit phonologic priming? Timing appears to be critical. The present data suggest that posterior aphasic patients are helped by phonologically related primes given *prior* to target production. In addition, the literature suggests that posterior aphasic patients are not helped by phonologically related cues given *after* unsuccessful attempts at target production. Posterior aphasic patients may be helped only by prior priming because an initial incorrect response cannot be inhibited, rendering later cueing ineffective. The present data and the literature suggest that anterior aphasic patients, in contrast to posterior patients, appear to be helped by phonologically related information given prior to target production.

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