Response Time Patterns for Word Production and Word Selection Anomias

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Most aphasic persons display some degree of word-finding difficulties (Wepman, 1951; Schuell, Jenkins, and Jiminez-Pabon, 1964). Qualitatively, these are manifested by circumlocutions, paraphasias, and self-corrections (Bisiach, 1966; Goodglass, Klein, Carey and Jones, 1966; Benton, Smith and Lang, 1972; Marshall, 1976; Farmer, 1977). Quantitatively, word-finding problems are reflected as naming delays. Response time studies have found that aphasic persons require more time than normals to evoke a target name (Newcomb, Oldfield, and Wingfield, 1965; Mills, Knox, Juola and Salmon, 1979; Brown and Cullinan, 1981). Theoretical explanations of aphasic word-finding problems tend to highlight these differences among patients (Geshwind, 1967; Luria, 1972; Buckingham, 1979). Benson (1979) has attempted to categorize types of word-finding difficulties exhibited by brain-injured persons. Two of his categories, word production anomia and word selection anomia, seem characteristic of aphasic persons. The former describes the efforts of the nonfluent client with serious articulation problems or the fluent aphasic individual whose verbal expression is noticeably contaminated by phonemic paraphasias and neologisms. The latter describes a retrieval deficit in which patients have difficulty selecting the correct word from the lexicon, but can provide the meaning of the word, or may be able to describe the object they cannot name.

Benson's categories of word production and word selection anomia appear to have some clinical utility in describing aphasic naming behavior. Accordingly, it may be possible to delineate anomic deficits using response time measures, and to relate these quantitative differences to qualitative observations (e.g., circumlocutions and paraphasias) of aphasic subjects' naming behavior. Unfortunately, most response time studies have only calculated the difference between stimulus presentation and production of the target response. This procedure has serious limitations in differentiating types of anomias. For example, one patient may sit silently for a few seconds before producing the target word "armadillo." A second may say "It's a rat, a skunk, an armadillo." The same response times could be registered for each response despite the fact the two responses are very different.

This study uses a methodology in making response time measurements that permits the specification of a response time pattern for each successful naming effort by the patient. The methodology involves three measurements. The first, Initial Response Time (IRT), denotes the time between stimulus presentation and the subject's first verbal response. The second, Final Response Time (FRT), designates the time elapsing from stimulus presentation to target naming, and corresponds to the response time measurements of previous studies (Newcomb et al., 1965; Mills et al., 1979; Brown and Cullinan, 1981). For the final measure the IRT is subtracted from the FRT (FRT-IRT$_{\Delta}$). By coding the IRT and FRT - IRT$_{\Delta}$ values as "delayed" or "normal," four response

patterns are possible: Normal-Delay, Delay-Normal, Delay-Delay, and Normal-Normal.

The purposes of this study were to ascertain (1) if response time patterns could be used to differentiate objectively the naming responses of aphasic subjects grouped by clinically observed type of naming deficit, and if patterns generated by groups coincided with what is currently believed about aphasic symptomatology.

METHOD

Subjects. Thirty-two normal adults and 36 aphasic individuals participated in this study. The aphasic subjects were assigned to groups according to the clinical features of their naming behavior. These groupings reflected the extent to which subjects' naming efforts revealed production and/or selection deficits. Group 1 (N=10) reflected mild word selection and production problems. Group 2 (N=10) exhibited moderately severe selection and production problems. Group 3 (N=10) manifested moderately severe selection difficulties and mild production deficits. Group 4 (N=7) illustrated mild selection problems but moderately severe production problems. Subjects are further described in Table 1.

Naming Task. Each subject was administered a confrontation naming task consisting of 40 line drawings of objects with names contained in the first 20,000 words of the Thorndike-Lorge list (Thorndike-Lorge, 1963). Stimuli were presented with an Ektagraphic carousel projector activated by Coulbourne Logic Circuitry which precisely controlled the stimulus exposure time (10 seconds) and interstimulus intervals (10 seconds). Presentation of the slide started an automatic counter. Production of a verbal response by the subject closed a voice-activated switch (within the logic circuitry), and produced a hard copy printout (in msec) on a paper strip. Using a separate switch, the examiner was able to indicate via a second channel printout when the subject had responded correctly. Normal subjects' responses were audiotaped. Those of the aphasic subjects were videotaped.

Latency Measures. Subjects' responses were transcribed from the tape and matched with hard copy printouts. The following measurements were made for each response.

Initial Response Time (IRT): The time (in msec)* between presentation of the stimulus and the subject's first verbalization.

Final Response Time (FRT): The time between the presentation of the stimulus and production of an accurate, intelligible response.

Final Response Time - Initial Response Time Difference (FRT-IRT▲): The difference between the FRT and the IRT.

RESULTS AND DISCUSSION

All normal subjects named the 40 stimulus items correctly. Mean IRT and mean FRT - IRT values and their standard deviations were calculated for the normal subjects for each stimulus. These data, shown in Table 2, provided reference ranges for normal response time patterns and were used to categorize the patterns of the aphasic subjects.

*All time measurements are in msec. To avoid repetition of the term, it will not be used further.

Table 1. Characteristics of aphasic subjects.

	Age		Month Onset		PICA %ile		BDAE Severity			
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Etiology	Type
Groups*										
1	36-72	56.7	1-21	6.9	61-93	76.7	3-5	4.0	9 Vascular 1 Trauma	4 Anomic 5 Broca's 1 Conduction
2	40-72	59.2	3-121	41.0	49-87	70.8	1-4	2.6	10 Vascular	3 Mixed 3 Broca's 2 Wernicke 1 Global 1 Conduction
3	34-61	52.2	2-32	9.9	51-91	71.7	1-5	3.2	9 Vascular 1 Tumor	5 Anomic 3 Broca's 1 Mixed
4	47-71	61.0	1-156	52.0	38-77	53.0	2-4	2.6	6 Vascular 1 Tumor	4 Broca's 3 Conduction

* Group 1 (10 males): Mild production and selection problems.
Group 2 (8 males, 2 females): Moderately-severe production and selection problems.
Group 3 (9 males): Moderately-severe selection problems and mild production problems.
Group 4 (7 males): Moderately-severe production and mild selection problems.

Table 2. Mean IRT and FRT - IRTΔ times and standard deviations of naming task items for the normal group.

	ITEM	$\bar{X}$ IRT	SD	$\bar{X}$ FRT - IRT	SD
1.	Coffee Pot	1782	650	47	208
2.	Bicycle	1428	564	0	0
3.	Rain	2145	673	136	373
4.	Haystack	2186	779	170	785
5.	Gloves	1643	422	0	0
6.	Blanket	1816	671	23	92
7.	Grasshopper	1789	500	8	43
8.	Boat	2073	811	168	499
9.	Tie	1655	354	35	196
10.	Dime	2416	959	290	624
11.	Peanuts	2463	1045	440	1403
12.	Lemon	1876	616	52	294
13.	Jet	2333	1083	57	242
14.	Nickle	2115	742	449	1115
15.	Sink	1812	538	123	527
16.	Garage	1878	616	28	132
17.	Farmer	2142	1001	215	708
18.	Seal	2051	837	140	590
19.	Hose	1777	610	0	0
20.	Alligator	1966	1119	218	1043
21.	Zebra	1474	384	42	235
22.	Spoon	1551	425	12	65
23.	Stairs	1881	696	203	463
24.	Airplane	2435	1406	123	440
25.	Leaf	1836	817	86	346
26.	Shovel	1756	816	45	251
27.	Mouse	1988	864	22	122
28.	Watch	1728	510	71	393
29.	Racoon	2177	763	29	154
30.	Fishing Rod	1873	639	35	198
31.	Clippers	1948	632	92	297
32.	Bus	1849	857	0	0
33.	Tire	2003	864	0	0
34.	Ear	1848	939	20	81
35.	Turtle	1762	715	65	361
36.	Walrus	2059	759	177	454
37.	Checkers	1874	720	158	824
38.	Trees	1943	737	39	219
39.	Clock	1761	522	0	0
40.	Mop	1840	630	154	481

The number of correct responses for the aphasic subjects ranged from 13 to 40 ($\bar{x}$=33.9). For each of the aphasic subjects' correct responses, the IRT and FRT - IRT$_\Delta$ times were compared to the mean values of the normal group (see Table 2). When an IRT or an FRT - IRT$_\Delta$ time exceeded the normal value by more than one standard deviation, it was coded as a "delay." If the time fell within one standard deviation, it was coded as "normal." Table 3 illustrates this procedure in an example of four aphasic subjects' responses to the stimulus "dime."

Table 3. Response time patterns of four aphasic subjects for the stimulus "dime." All values are stated in msec.

	IRT	SD	FRT - IRT$_\Delta$	SD
Normal Subjects	2416	959	290	624
Times for the four aphasic subjects				
Aphasic 1 Normal-Delay	2100		2400	
Aphasic S2 Delay-Normal	3800		450	
Aphasic S3 Delay-Delay	3950		1300	
Aphasic S4 Normal-Normal	2100		520	

The number of responses for the Normal-Normal (NN), Normal-Delay (ND), Delay-Normal (DN), and Delay-Delay (DD) patterns were calculated for each aphasic subject and proportions for the pattern types were computed for subjects and for the four groups. These data were used to carry out a series of single classification analyses of variance (Winer, 1971) to examine proportional differences in the occurrence of response patterns between the aphasic groups. When proportional differences were significant, Neuman-Keuls tests were conducted to determine which of the means were significantly different.

Figure 1 shows the group mean proportions for each response time pattern. ANOVA results showed mean proportions to differ significantly for all pattern types ($p < .01$). Results of Neuman-Keuls tests indicated the following. Group 1 (mild production and mild selection deficits) had a significantly higher proportion of NN patterns (.739) than any other group. None of the other groups differed with respect to the proportional occurrence of this pattern. This group contained a mixture of aphasic types, but they were distinguished from other subjects on the basis of their mild aphasic deficits as measured by PICA and BDAE severity ratings (see Table 1).

Group 4 (moderately-severe production and mild selection deficits) had significantly higher proportions of ND patterns (.355) than any other group. None of the other groups differed. The patients in this group often stated they "knew the word but couldn't say it." Some of these subjects reflected Broca's aphasia with accompanying apraxia of speech, while others exhibited conduction aphasia. For these subjects, naming efforts were initiated rapidly but successful naming was often preceded by articulatory struggles, revisions, and self-corrections. The large FRT - IRT$_\Delta$ values for the group

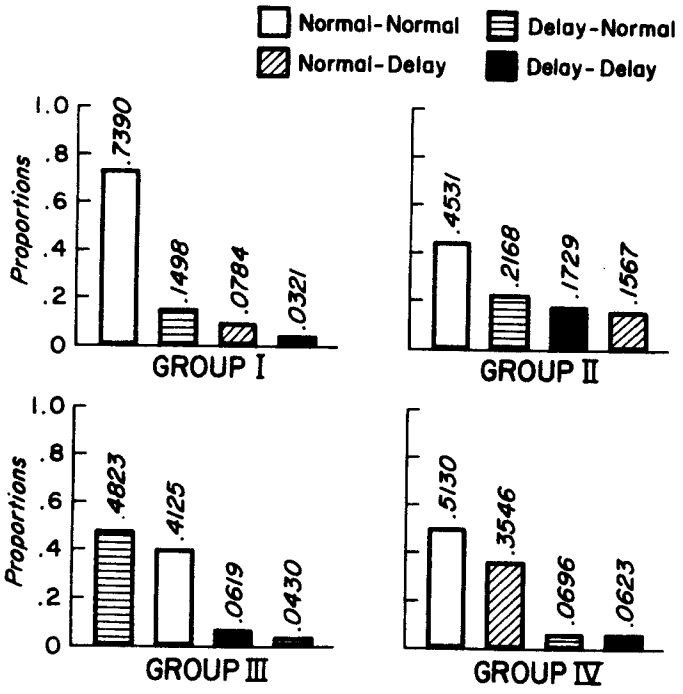

Figure 1. Group mean proportions for each response time pattern.

supported the clinical impression that the basis for their naming deficits were production problems rather than selection problems.

Group 3 (mild production and moderately-severe selection deficits) had a significantly higher proportion of DN patterns (.483) than any other group. None of the other groups differed. This group was composed of Broca's aphasic subjects without noticeable apraxia of speech, and anomic patients. For this group, a silent period often followed a stimulus presentation. This resulted in delayed IRT values. This silent period may represent the time needed by the subject to select the appropriate word from the lexicon. After this selection had occurred, these patients produced the name without hesitation, resulting in an FRT - IRT$_{\Delta}$ within normal limits.

Group 2 (moderately-severe production and moderately-severe selection deficits) had a significantly higher proportion of DD (.173) patterns than any other group. None of the other groups differed. The DD pattern suggests deficits in both production and selection. This group reflected a mixture of aphasic types, but more severe aphasic deficits than in Group 1. This group reflected the greatest variety of response time patterns.

It was not entirely unexpected that three of the four aphasic groups evidenced more NN patterns than any other pattern. The cutoff range of the normal mean plus one standard deviation was lenient and resulted in many latency times of aphasic subjects being coded as normal. While direct comparison of actual values might have resulted in more discernible differences between aphasic subjects and normals, the designation of response time patterns allowed for a differentiation of the performances of aphasic groups. In this vein, it is interesting that Newcomb et al. (1965) were

compelled to reject the responses of aphasic subjects who, following presentation of the stimulus, made two or more verbal interjections before correctly naming the stimulus. It was precisely the characteristic of this type of response we hoped to capture using response time patterns.

The findings of this study show that response time patterns provide a convenient and objective means for studying naming behavior in aphasia. Patterns exhibited by aphasic subjects grouped according to clinically observed naming problems support the notion that different mechanisms underlie anomias in aphasia. While the patterns that occurred most frequently for the four groups were predictable in terms of our clinical observations, a cautious interpretation is warranted. First, it can only be inferred that the immediate verbalization and delayed FRT - IRTΔ characteristics of the ND pattern indicates that the patient "knows the word but cannot say it" or that the silent delay preceding correct naming that typified the DN pattern means the patient is having trouble accessing the verbal lexicon. Secondly, our data are confounded by a problem of circularity inasmuch as we grouped our subjects by observed types of naming deficits before carrying out the experiment. Retrospectively, it would have been better to let the grouping of subjects be determined by the most frequently occurring response time patterns reflected on the naming task. Our study does, however, support the contention that different types of anomias exist among aphasic patients (Benson, 1979; Buckingham, 1979; 1981). Further research is necessary before the anomias of brain-injured persons are fully understood.

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