# Can We Learn More from Word Fluency Measures with Aphasic, Right Brain Injured and Closed Head Trauma Patients?

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Word fluency measures often are obtained during diagnostic evaluations of neurologically impaired patients. The most frequently used controlled association, word fluency tasks include the animal-naming subtest of the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass and Kaplan, 1972); the word fluency subtest of the Neurosensory Center Comprehensive Examination for Aphasia (NCCEA) (Spreen and Benton, 1977); and word fluency measures suggested by Wertz (1979).

During administration of the animal naming subtest of the BDAE, the patient is asked to name as many animals as possible in 60 seconds. Norms are available by age, and the authors found this subtest correlated highly with visual confrontation naming and responsive naming. A high negative correlation was found with phrase-length ratings (Goodglass and Kaplan, 1972).

Borkowski, Benton and Spreen (1967) reported normative data for 24 of the 26 letters of the alphabet. The authors reported that the number of associations produced was related to difficulty as defined by the Thorndike Lorge count and to the number of words listed per letter in Webster's New Collegiate Dictionary. The most difficult letters, which elicited the fewest number of associations in 66 normal adults, differentiated patients with right hemisphere and left hemisphere damage. Left hemisphere damaged patients gave the fewest associations. Both brain damaged groups generated fewer words than normal subjects.

The word fluency subtest of the NCCEA examines a patient's ability to recall words beginning with the letters F, A, and S with one minute allocated to each letter. Proper names and words differing only in suffix are excluded. Normative data are available in the test manual.

Wertz (1979) suggested that word fluency measures could be used to assess mild aphasia. He described a word fluency test that included the easier letters S, T, P and C. In this test, proper names are permitted and a 60-second recall period is given for each letter. Wertz and Lemme (1974) and Wertz, Keith and Custer (1971) provided normative data. Wertz et al. (1973) reported correlations between this word fluency measure and PICA overall scores, PICA verbal performance scores, and the last section of the Token Test.

Word fluency scores typically represent the total number of words generated during a specified period of time. The purpose of this investigation is to identify qualitative measures which would point to the existence of strategies used by subjects during controlled association recall tasks.

Subjects. Subjects included ten closed head injured individuals (7 male, 3 female); eight high-level nonfluent aphasic patients with left hemisphere damage (4 male, 4 female); nine right hemisphere damaged patients (5 male, 4 female); thirteen normal subjects younger than age 50 (3 male, 10 female); and twelve normal subjects older than age 50 (4 male, 8 female). All brain damaged subjects were at least 6 months post injury and were matched by age

and amount of education to one of the normal control groups. Subject group descriptive data are presented in Table 1. Subjects in the right or left hemisphere damaged groups sustained single cerebrovascular accidents and displayed unilateral damage based on CT scan or neurological examination.

Table 1. Subject descriptive information.

| EXPERIMENTAL GROUPS | EXPERIMENTAL SUBJECTS | | | | | |
|---|---|---|---|---|---|---|
| | AGE (YEARS) | | EDUCATION (YEARS) | | TIME POST INJURY (MONTHS) | |
| | Range | $\bar{X}$ | Range | $\bar{X}$ | Range | $\bar{X}$ |
| 1. Closed Head Trauma N:10 | 17-34 | 22.83 | 11-16 | 12.69 | 6-21 | 10 |
| 2. Left CVA N:8 | 49-72 | 62.5 | 8-18 | 10.7 | 7-174 | 60.87 |
| 3. Right CVA N:9 | 62-82 | 75.5 | 7-16 | 10.8 | 7-144 | 29 |
| 4. Young Normals <50 N:13 | 16-29 | 23 | 8-16 | 13.5 | NA | NA |
| 5. Older Normals >50 N:12 | 51-80 | 63.27 | 10-18 | 12.83 | NA | NA |

The Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1972) was administered to patients with left hemisphere damage to evaluate severity and type of language impairment. All subjects in this group were classified as demonstrating nonfluent, (Broca's) aphasia according to guidelines provided by Goodglass, Quadfasel, and Timberlake (1964). All subjects were considered to be mildly impaired, because their conversational and expository speech ratings indicated minimal difficulty (severity ratings 4-5) with earned Z-scores above the mean on subtests in all language modalities. All subjects were right-handed and English speaking only.

## METHOD

Subjects were asked to say as many words as possible beginning with the letters S, T, P and C in a 1-minute period per letter. No words were restricted. The total number of responses were calculated for the following categories:

1. real words
2. frequently occurring words (Jones and Wepman, 1966, A Spoken Word Count, List B)
3. one-syllable words
4. words with identical vowels (e.g., cod, cot, cop)
5. words with identical final letters and different vowels (e.g., cot, cat, kit)
6. semantically associated words (e.g., snow, ski, sled)
7. homonyms (e.g., to, too, two)
8. words formed by changing the second syllable of a word given previously (e.g., convince, convey, content)

9. words with identical initial blends (e.g., crane, crock, creep)
10. words for which no strategy could be discerned.

When calculating the frequency of occurrence of specific strategies, the first word given in response to each of the four letters S, T, P or C was not counted since it would have not been possible to discern the cognitive process or strategy which lead to the selection of the word. For the same reason, when a strategy used to generate words changed during the task, the first word representing a new strategy was not counted (e.g., snow, ski, street (not counted) string, strain).

## RESULTS

A Wilcoxon Rank Summary Test was used to analyze the differences in the various response categories between mean scores of the experimental groups. All mean scores were converted to proportions reflecting the ratio of the category score to the total number of responses. Tables 2 and 3 summarize the results.

Table 2. Summary of responses made on a word fluency task by young normal, older normal, CHT, LCVA and RCVA patients.

| Subjects | Total Words Generated | RESPONSE TYPES (PERCENTAGE OF TOTAL) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Frequently Used Words | 1-Syllable Words | Strategies Utilized | | | | | | | | |
| | | | | Same Vowel | Same Final Letters (Diff. vowel) | Semantic Similarities | Homonyms | Changed Ending | Same Initial Blend | Change Strategy | 1st Wd. in 4 Lists (Not Counted) | No Discernible Strategy |
| YOUNG NORMAL | 51 | 40 | 60 | 18 | 3 | 14 | 0 | 7 | 13 | 0 | 7 | 39 |
| OLDER NORMAL | 46 | 46 | 56 | 14 | 3 | 14 | 2 | 9 | 14 | 1 | 10 | 33 |
| CLOSED HEAD TRAUMA | 37 | 45 | 44 | 12 | 6 | 8 | 0 | 7 | 8 | 18 | 11 | 30 |
| L-CVA | 35 | 45 | 58 | 9 | 5 | 6 | 4 | 14 | 7 | 14 | 12 | 29 |
| R-CVA | 37 | 36 | 61 | 15 | 4 | 9 | 1 | 5 | 10 | 12 | 11 | 33 |

## DISCUSSION

All groups, normal and brain damaged, performed similarly with regard to the strategies used most often to generate lists of words. The strategies utilized most often by the experimental groups are listed in Table 4. Strategies not often used by the experimental groups included: identical final letters (cot, cat), homonyms (to, two) and changing endings (convey, convince, content).

Table 3. Summary of results of analysis of types of responses made by the experimental subjects on a word fluency task using the Wilcoxin Rank Summary Test. Degree of Significance (* = .05, ** = .01).

| | SUBJECTS 1 - 2 | RESPONSE TYPES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ident. Vowels 1 | Ident. Final Letters 2 | Semantic Similarity 3 | Homonyms 4 | Freq. Wds. 5 | 1 Syl. Wds. 6 | Change Ending 7 | Total 8 | No Strategy 9 | Ident. Initial Blend 10 |
| YOUNG NORMALS | YN-ON | | | | | | | | | 1>2 * | |
| | YN-CHT | 1>2 * | | | | | 1>2 ** | | 1>2 ** | 1>2 ** | |
| | YN-LCVA | 1>2 ** | | 1>2 * | | | | | 1>2 ** | 1>2 ** | |
| | YN-RCVA | | | | | | | | 1>2 ** | 1>2 * | |
| OLD NORMALS | ON-YN | | | | | | | | | 1<2 * | |
| | ON-CHT | | | 1>2 * | | | | | 1>2 * | | |
| | ON-LCVA | | | 1>2 ** | | | | | 1>2 ** | | |
| | ON-RCVA | | | | | 1>2 * | | | 1>2 * | | |
| 6 MOS.POST HT | CHT-YN | 1<2 * | | | | | 1<2 ** | | 1<2 ** | 1<2 ** | |
| | CHT-LCVA | | | | | | | 1<2 * | | | |
| | CHT-RCVA | | | | | | 1>2 ** | | | | |
| | CHT-ON | | | 1<2 * | | | | | 1<2 * | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| LEFT CVA | LCVA-RCVA | | | | | | | 1>2 ** | | | |
| | LCVA-YN | 1<2 ** | | 1<2 * | | | | | 1>2 ** | 1<2 ** | |
| | LCVA-ON | | | 1<2 ** | | | | | 1<2 ** | | |
| | LCVA-CHT | | | | | | | 1>2 * | | | |
| | LCVA-RCVA | | | | | | | 1>2 * | | | |
| RIGHT CVA | RCVA-YN | | | | | | | | 1<2 ** | 1<2 * | |
| | RCVA-ON | | | | | 1<2 * | | | 1<2 * | | |
| | RCVA-LCVA | | | | | | | 1<2 ** | | | |
| | RCVA-CHT | | | | | | | | | | |

Table 4. Strategies utilized most often by experimental groups to generate lists of words.

| GROUPS | 1ST | 2ND | 3RD | 4TH | 5TH |
|---|---|---|---|---|---|
| Younger Normal | 1 Syllable Words | Frequently Occurring Words | Identical Vowels* | Semantic Similarities* | Identical Initial Ble |
| Older Normal | 1 Syllable Words | Frequently Occurring Words | Identical Vowels* | Semantic Similarities* | Identical Initial Ble |
| Prior 6 mos. Head Trauma | 1 syllable Words | Frequently Occurring Words | Changing Endings | Identical Vowels | Semantic Similariti Ident. Init Blend* |
| 6 mos. Post Head Trauma | Frequently Occurring Words | 1 Syllable Words | Identical Vowels | Semantic Similarities* | Identical Initial Ble |
| Right CVA | 1 Syllable Words | Frequently Occurring Words | Identical Vowels | Identical Initial Blends | Semantic Similaritie |
| Left CVA | 1 Syllable Words | Frequently Occurring Words | Identical Vowels | Identical Initial Blends | Semantic Similaritie |

* Identical Mean Number

The brain-injured groups changed strategies during the task significantly more often than either normal control group. An analysis (by inspection) of the responses made by the brain-injured groups revealed that the Closed Head rauma group changed strategies during the task most often, while the Right CVA group changed strategies least often.

The ability to generate lists of words declined as a function of age as well as the presence of brain damage. The Young Normal group generated more words than the other experimental groups did, including the Older Normal group. However, both the young and older normal groups generated significantly more words and used more strategies than the brain-injured groups. The Young Normal group used fewer strategies than the Older Normal group. The use of strategies might be a normal compensatory technique that develops with age. Another possibility is that the young control subjects used strategies which were not obvious, because they gave the largest number of words in the "no discernible strategy" category.

The Left CVA group used significantly fewer semantic associations than other subject groups did. The language disturbances of the subjects in this group might have affected the utilization of specific word recall strategies. The aphasic patients used the strategy of changing endings (child-children, or prosper-prosperity) significantly more often than the Right CVA group and the Head Trauma group. This might be a strategy which is used to compensate for language or word finding deficits, because it builds on each word generated rather than requiring new words to be generated on each trial. Patients with left hemisphere damage generated the smallest number of words and utilized more strategies than the Closed Head Trauma and Right CVA groups. It appears that the left hemisphere damaged group benefited less from the strategies used than the Closed Head Trauma and Right CVA groups did.

The Right CVA group differed significantly from the Closed Head Trauma group on only one of the measures (use of one-syllable words). The subjects in these groups responded similarly when compared to subjects in the Left CVA group. The Right CVA group used a "semantic similarity" strategy significantly less often than the older normal group did. Perhaps this is the result of a general cognitive deficit causing disability in processing or imagining whole events or situations. Right hemisphere damaged patients might utilize strategies which are based on individual segments of words, such as identical vowels or initial blends as a result of sequential or analytical processing by an unaffected left hemisphere. Only the Right CVA group differed significantly from the older normal group with regard to the use of frequently occurring words. The Right CVA group gave fewer frequently occurring words than all of the other experimental groups.

The Closed Head Trauma group generated more words overall than the Left CVA group and the same number as the Right CVA group, however, they used fewer strategies overall than both of these groups. The closed head injured group produced significantly fewer identical vowels and 1-syllable words than the young normal group. Approximately 40% of the total responses for every group were frequently occurring words. The young normal, older normal and Right CVA groups produced the greatest number of words in the "no discernible strategy" category.

It appears that clinicians can learn from word fluency measures administered as part of diagnostic evaluations with neurologically impaired patients. Qualitative measurements (in addition to usual quantitative analyses) differed significantly between left-hemisphere-damaged aphasic subjects, subjects with right hemisphere damage, subjects with diffuse damage secondary to closed head trauma, and control groups consisting of younger and older subjects. Qualitative analyses of performance on word fluency tasks

could identify specific areas of deficit as well as strategies which tend to be spontaneously utilized by a patient. The feasibility of improving the performance of neurologically impaired patients on word recall and naming tasks via the facilitation of recall strategies needs to be experimentally determined.

## REFERENCES


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## DISCUSSION

Q: How did you identify the strategy categories in your taxonomy?

A: A strategy was defined as any systematic method utilized by individuals to facilitate free recall. Our determination of strategies for this specific task was made following analyses of data collected over the past several years.

Q: Was there a lot of variability within each group?

A: No. The subjects within each group performed similarly with regard to the type of strategies utilized. Subjects within each group did vary in the number of words recalled.

Q: Some people feel that fluency and word association measures do not appear to be associated with or related to specific types of brain damage. Did you find any variables, such as comprehension difficulties or verbal difficulties with left hemisphere damaged patients which were specifically related to word fluency?

A: Previous questioning regarding the diagnostic value of word fluency measures might be due to the fact that word fluency scores typically refer to the number of responses only. Qualitative analyses are usually not done. The results of this investigation suggested differences between groups of brain damaged patients on qualitative measures. In this study, all the patients with left hemisphere brain damage exhibited nonfluent, Broca's aphasia. A study comparing patients with different types of aphasia might provide additional diagnostic information.

Q: Did any of your patient groups use counterproductive strategies?
A: The purpose of this investigation was to analyze productive strategies. However, I can report some of my observations. The closed head trauma patients and the right hemisphere damaged patients tended to repeat the same words and they did not appear to be aware of this. Both of these patient groups also tended to give up, whereas the patients with left hemisphere damage kept trying to recall words throughout the 60-second period.

Q: Were the differences that you found between groups discriminating enough that you were able to look at a response profile of a patient and use it diagnostically to identify the type of brain injury, i.e. left brain damaged, closed head trauma, etc.?
A: The patient groups could be distinguished with regard to the strategies utilized most often and least often. Group mean scores of remaining strategies tended to overlap between groups, possibly due to the small number of patients tested. An attempt to establish a complete profile would require the testing of more patients in each experimental group.

Q: Were there any reliability problems making a decision about the use of a specific strategy? It's easy to see the strategy in a word string such as "connect, confabulate, convince, etc.", but semantic strategies are less obvious. How did you make these decisions?
A: If a strategy was not obvious, the word was counted in the "no discernible strategy" category in an attempt to address the issue of reliability.

Q: Your study supports the way some of us define aphasia. The left hemisphere damaged patients demonstrated the presence of more strategies but the fewest number of words. This might suggest that these people are pretty good at developing plans and ways of solving problems but they don't have the tools to carry them out.
A: That's an important point. Carrying this point a bit further, analyses of qualitative word fluency measures might suggest the appropriateness of different types of treatment to compensate for different types of problems experienced by brain damaged patients with different lesion sites.