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## Evolution of phonemic word fluency performance in post-stroke aphasia

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### Abstract

In this longitudinal study, quantitative and qualitative changes in responses of people with aphasia were examined on a phonemic fluency task. Eighteen patients were tested at 3-month intervals on the letters F-A-S while they received comprehensive, intensive treatment from 3 to 12 months post-stroke. They returned for a follow-up evaluation at an average of 10 months post-intervention. Mean group scores improved significantly from beginning to end of treatment, but declined post-intervention. Patients produced a significantly greater number and proportion of modifiers (adjectives and adverbs) between the beginning and end of treatment, with no decline afterwards, implying that they had access to a wider range of grammatical categories over time. Moreover, patients used significantly more phonemic clusters in generating word lists by the end of treatment. These gains may be attributed to the combined effects of time since onset and the linguistic and cognitive stimulation that patients received in therapy. *Learning outcomes:* Readers of this paper should (1) gain a better understanding of verbal fluency performance in the assessment of aphasia, (2) recognize the importance of analyzing qualitative aspects of single word production in aphasia, and (3) contribute to their clinical judgment of long term improvement in aphasia.

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## 1. Introduction

Word fluency tasks are included in a broad range of aphasia assessment instruments, yet the clinical relevance of performance on word fluency tasks is not commonly addressed. The gap in our understanding may be the result of limited research on the qualitative attributes of the words generated by people with aphasia on verbal fluency tasks. The purpose of this study was to examine the quality of responses over a period of up to 2 years post-stroke.

The most commonly used verbal fluency measures are phonemic tasks that are letter-based, or those based on semantic categories (e.g., animals, foods) (Spreen & Risser, 2003). Letter fluency tasks, generally referred to as “phonemic” or “orthographic” fluency measures, are unlike most other measures of aphasia in that they are timed and, other than initial letter stimuli, are totally unconstrained. In the verbal fluency task included in the *Neurosensory Center Comprehensive Examination of Aphasia* (NCCEA) (Spreen & Benton, 1977), patients are allotted 60 s to generate words beginning with the letters F, A and S, respectively. The *Controlled Oral Word Association* (COWA) of the *Multilingual Aphasia Examination* (Benton, Hamsher, & Sivan, 1994), comprises two tests, one with the letters C-F-L and a second one, used mostly for repeat testing, with the letters P-R-W.

Norms have been established for several different versions of the phonemic word fluency task (hence, ‘WF’). According to Spreen and Risser (2003), neurologically intact adults produce on average approximately a dozen words beginning with a particular letter (e.g., the letter ‘S’) in a span of 60 s. This norm is supported by Wertz and Lemme (1974) who tested a group of healthy people using the letters S-T-P-C, and reported an average of about 14 words per letter. Ruff, Light, Parker, and Levin (1996) found an average of approximately 13 words per letter using the letters C-F-L in a group of 360 healthy adults. Numerous studies have established a positive effect of education, specifically literacy, on phonemic WF performance (e.g., Capitani, Laiacona, & Basso, 1998; Ratcliff et al., 1998; Ruff et al., 1996).

Verbal fluency performance has been compared in diverse healthy and pathological populations. Deficits in performance have been associated with damage to areas of the brain subserving language, especially the left hemisphere (e.g., Borkowski, Benton, & Spreen, 1967; Vilkki & Holst, 1994). Imaging studies with neurologically intact adults have revealed specific involvement of the left dorsolateral prefrontal cortex (Ruff, Light, Parker, & Levin, 1997). Using Positron Emission Tomography (PET) with a group of 22 patients with aphasia due to stroke, Karbe, Kessler, Herholz, Fink, and Heiss (1995) reported significant improvements on the F-A-S task between 3 weeks and 2 years post-stroke associated with increased metabolic rate in roughly the same area of the left frontal lobe.

Patients with aphasia generally have lower scores than neurologically intact controls and brain-damaged patients without aphasia. Spreen and Benton (1977) reported a mean score of 11.5. Basso, Burgio, and Prandoni (1997) tested Italian-speaking brain-damaged patients with and without aphasia on the letters P-L-F. While both groups of brain-damaged patients did significantly worse than normal controls, the mean score of 14.7 for the group with aphasia was significantly lower than the mean score of 22.9 for the group without aphasia. Patients with aphasia secondary to closed head injury achieved a mean at

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