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FAS and CFL Forms of Verbal Fluency Differ in Difficulty: A Meta-analytic Study

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Abstract

The Controlled Oral Word Association (COWA) Test is a brief and sensitive measure of executive cognitive dysfunction. There are two commonly used forms of the test, one using the letters F, A, and S, and the other using C, F, and L. This study examines the relative difficulty of the two forms using a meta-analytic approach that includes multiple samples of normal individuals. The effects of age, education, gender composition, exclusion criteria, and age of study are also examined. Results indicate that the CFL form of the test is more difficult and that age, education, and the use of strict exclusion criteria influence performance. Performance is more variable for the FAS form, and age and age of study influence performance variability.

Keywords

Verbal Fluency; Controlled Oral Word Association Test; COWA; FAS; CFL

Introduction

An oral Verbal Fluency Test was first developed by Arthur Benton over 40 years ago (Mitrushina, Boone, & D'Elia, 1998). It was included in the Multilingual Aphasia Examination (Benton & Hamsher, 1976) in a slightly different form and with a new name, the Controlled Oral Word Association (COWA) Test. This test, also known as the phonemic or letter fluency test, requires test takers to name as many words beginning with a single letter as they can in one minute. Standard administration provides three letters. The most commonly used form of the test today uses the letters F, A, and S (Spreen & Strauss, 1998), but the form included in the Multilingual Aphasia Examination (Benton & Hamsher, 1976) uses the letters C, F, and L or P, R, and W. Although the name COWA is most accurately applied to the CFL/PRW form of the test, it has been widely adopted to describe the FAS form as well. Other versions of the letter fluency test that use different letters or different numbers of letters are included in a variety of test batteries (Spreen & Strauss, 1998). For example, the Test of Verbal Conceptualization and Fluency (TVCF; Reynolds & Horton, 2006) includes a verbal fluency test employing the letters P, D, S, and T, and the Delis-Kaplan Executive Function Scale (D-KEFS; Delis, Kaplan, & Kramer, 2001) includes the FAS form and a version using B, H, and R. Although it was developed as a test of verbal ability, the COWA is also considered a test of executive functions, including cognitive organization, initiation, maintenance of effort, and the ability to conduct a non-routine search for words based on a specific first letter, rather than lexical definition (Andrewes,

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2001; Devinsky & D'Esposito, 2004; Walsh & Darby, 1999). This interpretation is consistent with research showing poor performance in individuals with frontal lobe lesions (Ruff, Allen, Farrow, Niemann, & Wylie, 1994; Walsh & Darby, 1999) and sensitivity to cognitive dysfunction in disorders that affect executive functions (Henry & Beatty, 2006).

There is some evidence that different forms of the COWA have different levels of difficulty. Borkowski, Benton, and Spreen (1967) classified the letters C, F, P, A, and S as easy letters and the letters L and R as difficult letters based on the English vocabulary size for each letter. The FAS test thus includes only easy letters, whereas the CFL/PRW norms are based on fluency in response to two easy and one difficult letter (Bolla et al., 1990; Lacy et al., 1996; Ruff, Light, Parker, & Levin, 1996). Although comparison of norms for the FAS and CFL forms of the COWA suggest some differences in difficulty, these differences are difficult to interpret due to the use of different samples for each form (see Spreen & Strauss, 1998, for summary). Lacy et al. (1996) studied the equivalence of the two forms in a sample of 287 patients with various neuropsychological complaints. They administered the letters A, C, F, L, and S to each patient in various orders and then compared performance on CFL and FAS groupings. The two forms correlated highly in all patient groups, suggesting that interpretation of FAS using CFL norms would be accurate, at least in clinical samples (Lacy et al., 1996).

In addition to the form of test used, effects of demographic variables are important to consider when interpreting COWA results. Age effects have failed to emerge in many studies (Axelrod & Henry, 1992; Bolla et al., 1990; Ruff et al., 1996; Selnes et al., 1991), although some studies have shown modest age effects, with higher age predicting poorer performance (Libon et al., 1994). Higher education has been associated with better COWA performance in several studies (Ruff et al., 1996; Selnes et al., 1991; Tombaugh, Kozak, & Rees, 1999). Some studies find superior performance on the COWA in women compared to men (Bolla et al., 1990; Ruff et al., 1996), although other studies find no difference between men and women (Boone, 1999; Saykin et al., 1995; Tombaugh et al., 1999).

This study uses multiple regression analysis to examine the influence of form of administration (FAS or CFL) on COWA performance in a large sample comprising multiple published and unpublished studies of normal participants. It also examines the influence of age, education, and gender on mean performance. Influences on the variability of performance were also examined by analyzing the effect of independent variables on the standard deviation of the mean. The meta-analytic methodology employed allows for the examination of two other factors that could influence the applicability of normative samples: the strictness of the exclusion criteria, and the recency of data collection.

Method

Data Collection

Data were collected from published journal articles, normative studies, and unpublished dissertations reporting data obtained from normal, English-speaking participants. Studies were identified through searches of three computerized databases, PsychInfo, Medline, and Web of Science, using the terms verbal fluency test, controlled oral word association, COWA, and *word fluency* as keywords. A manual search of issues of *Neuropsychology*, *The Clinical Neuropsychologist*, the Journal of Clinical and Experimental Neuropsychology, Archives of Clinical Neuropsychology, and the Journal of the International Neuropsychological Society between 1997 and March 2006 was also conducted. Additional studies were identified from the references in studies obtained by the first two methods. Once identified, publications examining normal participants and reporting mean scores for the tests and at least one of three demographic variables (age, education, or gender

composition) were included. Studies that used non-standard test administration procedures or that failed to report the form of COWA used were excluded. Only studies conducted in the United States or Canada were used, because differences in educational systems in other English-speaking countries would interfere with analysis of education effects.

Procedure

The following data were entered into an Excel spreadsheet for each study: mean test score, standard deviation of the mean, age, education, gender composition, year of study, exclusion criteria, and form of test (FAS, CFL) used. Test form and exclusion criteria were dummy coded for inclusion in the regression analysis. Studies using the FAS form of the COWA were coded 1, and those using the CFL form were coded 2. Studies that excluded participants based on at least three characteristics (history of neurological illness, history of significant head injury, history of psychiatric illness, history of significant medical illness, current substance use disorder), were coded 1, and those that did not employ at least three exclusion criteria were coded 0. The sample included 134 studies. Table 1 shows the demographic characteristics of the studies, and Table 2 shows characteristics of the sample included.

Data Analysis

Mplus statistical software (Muthén & Muthén, 1998) was used for data analysis. A full information maximum likelihood (FIML) method was used to produce unbiased parameter estimates assuming that data are missing at random (Allison, 2001; Muthén & Muthén). Multiple regression analyses yielded regression equations for the sample means and standard deviations of each test. Following the initial analyses, regression weights of non-significant variables were set to zero, and the analyses rerun, in order to obtain model fit indices. Variables that approached but did not reach significance were not set to zero. Most independent variables were normally distributed. Education was negatively skewed, indicating a higher proportion of scores at the higher end of the distribution. Square root, log, and inverse transformations were conducted on the education variable, but these transformations did not alter the results of the analyses, so the original analyses with untransformed variables were retained in order to avoid difficulty interpreting the effects of substantive differences in independent variables. Effect sizes for each independent variable were obtained as the unique variance accounted for by that variable.

Results

The regression equation for the mean fit the data well when non-significant variables were set to zero ($\chi 2 = 0.831$, $df = 2$, $p = 0.6582$, RMSEA = 0.00, 90% CI = 0.00 – 0.13, SRMR = 0.01, CFI = 1.00, TLI = 1.00). Gender and year of study were not significant in the preliminary analysis and were set to zero for the purpose of obtaining fit indices. Age and education were significantly associated with mean performance on the Verbal Fluency Test. Older age predicted worse performance, higher education predicted better performance, and the effect sizes for both variables were large. Exclusion criteria also had a significant effect on mean performance. More words were produced in studies with stricter exclusion criteria, with a medium effect size. Test form was also a significant predictor of mean performance, with worse mean performance in studies using the CFL form, but the effect size was small. The mean score for the FAS form of the test was 40.48 (6.08), and the mean score for the CFL form was 38.66 (5.55). The independent variables accounted for 47% of the variance in mean scores.

The regression equation for the standard deviation of the mean also fit the data well when non-significant variables were set to zero ($\chi 2 = 2.489$, $df = 3$, $p = 0.4762$, RMSEA = 0.00,

90% CI = 0.00 – 0.14, SRMR = 0.02, CFI = 1.00, TLI = 1.00). Age was associated with standard deviation; there was greater variability in older samples. Age of study also predicted variability of performance, with less variability in older studies. Form was a significant predictor of standard deviation as well, suggesting greater variability in samples employing the FAS form of the Verbal Fluency Test. The effect sizes for age of study and form were large. The independent variables accounted for 15% of the variance in the standard deviation of COWA performance.

Table 3 shows the unstandardized beta weights for each variable retained in the second analysis. Table 4 shows the effect sizes represented as percent of variance accounted for by each variable.

Conclusions

The results of this study suggest that the CFL form of the COWA Test is more difficult than the FAS form and that there is greater variability in performance on the FAS form among normal individuals. Because the range of normal scores is narrower for CFL, interpretation of results from the two forms could be different for individuals whose scores lie at the extremes of the distribution where the effect of differences in standard deviations may be amplified. These results are inconsistent with findings from the study by Lacy et al. (1996) showing comparable performance on the two forms in clinical samples. One implication of these results is that performance on one form of the test cannot be accurately interpreted using norms based on the other form. Similarly, comparisons of raw scores on the two forms of the test, such as might be used in a pre- and post-intervention evaluation of cognitive ability, should be made cautiously, if at all.

Although previous studies have been inconsistent in their support of age as a variable influencing COWA performance, this study indicates that older adults will perform more poorly than younger adults and that their performance will be more variable. Verbal ability is generally considered a crystallized ability, one that does not decline with age or in response to subtle brain dysfunction, but verbal fluency, particularly phonemic fluency, requires executive ability, specifically the ability to initiate and maintain effort and organize information for retrieval, abilities that are sensitive to subtle cerebral dysfunction and aging (Bryan & Luszez, 2000; Burke & Barnes, 2006; Henry & Beatty, 2006; Mittenberg, Seidenberg, O'Leary, & DiGiulio, 1989; Plumet, Gil, & Gaonac'h, 2005). Education was a potent predictor of performance, consistent with prior research. Higher education predicted better performance. Previous research on the effect of gender on Verbal Fluency performance has been inconsistent. This study indicates that gender does not influence verbal fluency.

Overall, these results support the importance of using norms stratified by age and education, but not gender, when interpreting COWA performance and suggest caution in using the two forms of the test interchangeably.

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Appendix A

Studies included in the analysis.

Study	N	Mean Score	SD	Mean Age	Mean Education	% Male	Strict Exclusion Criteria	Form
Axelrod & Henry (1992)	20	41.1	9.9	55.3	15.4	50	Yes	FAS
	20	39.6	10.7	65.2	14.4	50	Yes	FAS
	20	36.0	9.3	74.3	14.5	50	Yes	FAS
	20	37.8	14.0	83.4	14.5	40	Yes	FAS
Basso et al. (2002)	31	44.0	9.16	34.09	14.91	9	Yes	FAS
Basso et al. (1999)	82	47.68	10.82	31.9	14.56	100	Yes	FAS
Beatty et al. (1989)	13	39.5	11.6	65.4	14.4		Yes	FAS
	15	38.4	8.2	63.9	11.0		Yes	FAS
Berry et al. (1993)	21	41.6	10.7	33.2	14.1	95	Yes	FAS
Bolla et al. (1990)	32	38	12	61	13	100	Yes	FAS
	25	43	12	63	14	100	Yes	FAS
	23	47	9	65	17	100	Yes	FAS
	33	42	9	61	13	0	Yes	FAS
	39	46	12	65	15	0	Yes	FAS
	47	49	12	69	16	0	Yes	FAS
Bolla et al. (1999)	21	36.3	10.0	33.9	12.6	81	Yes	FAS
Bondi et al. (2003)	43	39.05	10.29	66.72	14.67	56	No	FAS
	36	39.31	12.01	79.17	14.53	50	No	FAS
Boone et al. (1990)	25	43.56	6.51	54.5	14.68		Yes	FAS
	21	42.33	14.21	64.5	13.81		Yes	FAS
	15	36.0	8.93	74.5	14.53		Yes	FAS
Boone et al. (1995)	110	40.45	11.12	63.1	14.8	47	Yes	FAS
Caccappolo-Van Vliet et al. (2003)	155	39.0		67.9	15.1	40	No	CFL
Carone et al. (2005)	37	42.2	10.2	42.3	15.0	***	Yes	CFL
Cerhan et al. (2002)	221	34.01	11.31	76.1	13.7	41	Yes	CFL
Cerhan et al. (1998)	622	34.8	12.6	47		100	No	FAS
	1598	33.2	12.5	52		100	No	FAS
	1542	32.6	12.7	57		100	No	FAS
	1495	32.0	12.6	62		100	No	FAS
	846	31.6	13.0	67		100	No	FAS
	897	35.8	12.0	47		0	No	FAS
	2182	34.6	12.4	52		0	No	FAS
	2010	33.6	12.1	57		0	No	FAS
	1724	32.7	12.1	62		0	No	FAS
	864	31.8	12.6	67		0	No	FAS
Clark et al. (1997)	92	41.4	10.3	35.5	13.9	29	No	FAS
Clark et al. (2001)	30	48.7	13.8	37.6	15.6	53	No	CFL
Comilang (2003)	124	42.26	9.1	19.9		26	Yes	CFL
Connor et al. (2000)	15	45.5	11.8	24.3		100	Yes	FAS

Study	N	Mean Score	SD	Mean Age	Mean Education	% Male	Strict Exclusion Criteria	Form
Crossley et al. (1997)	139	24.0	12.4	69.6	8.2		No	FAS
	343	25.8	11.5	79.0	9.1		No	FAS
	146	24.0	10.8	87.8	8.8		No	FAS
Crowell et al. (2002)	80	33.56	10.7	37.95	12.98	100	No	FAS
DeLuca et al. (1998)	20	42.5	2.0	42.2	15.5		No	CFL
Demakis (1999)	21	37.8	11.1	22.5	13.6	33	No	CFL
Dinn & Harris (2000)	10	41.6	9.0	28.9	13.9	100	Yes	FAS
Dursun et al. (2002)	47	54	16	39	16.09	0	No	FAS
	28	57	15	27	14	100	No	FAS
Elmudesi (1995)	9	28.22	6.76	36.89	14.0	100	No	CFL
Feinstein et al. (1998)	11	44.1	12.0	25.3			Yes	FAS
Friedman et al. (1995)	24	44.29	12.5	35.8			Yes	FAS
Friend et al. (1999)	42	45.31	12.96	45.83	14.38	17	Yes	CFL
Garrett (2004)	25	40.7	15.2	76.5	12.4	44	Yes	FAS
Goldstein et al. (2001)	14	32.3	7.7	65.3	13.4	64	Yes	FAS
Gopal (1996)	10	47.7	9.74	40.3	14.3	90	Yes	FAS
Gourovitch et al. (1996)	24	42.36		33.04	14.04	22	Yes	FAS
Hall (1995)	20	41.1	8.09	32.45	14.3	30	Yes	FAS
Heaton et al. (1995)	111	45.82	10.04	33.1	14.7	100	Yes	FAS
Hildebrand (1996)	31	34.84	9.3	23.25		45	No	CFL
Hodges et al. (1990)	14	40.1		73.1	13.3	50	Yes	FAS
Johnson et al. (2006)	95	26.73	11.22	72.34	12.34	19	No	CFL
Johnson et al. (2001)	38	39.58	8.88	40.8	17.29	63	No	FAS
Johnson (2000)	145	42.28	14.25	78.74	16	43	Yes	FAS
Johnstone et al. (1995)	20	37.8		29.42	12.35	80	No	FAS
Kozora & Cullum (1995)	41	41.23	12.10	54.5	14.3	51	Yes	FAS
	43	45.76	14.26	64.6	14.2	37	Yes	FAS
	47	46.49	10.46	74.6	14.3	32	Yes	FAS
	43	40.74	11.9	83.8	14.9	37	Yes	FAS
Kozora et al. (1999)	31	46.3	13.4	69.9	13.3	51	Yes	FAS
Kramer et al. (2002)	27	41.0	14.0	72.82	15.67		Yes	FAS
Kremen et al. (2003)	83	40.5		41.1	13.69	41	Yes	FAS
Kuo (2001)	51	40.6	13.0	58.2	15.0	57	Yes	FAS
Lafleche & Albert (1995)	20	51.90	10.99	76.2	14.7	45	Yes	FAS
Lebowitz et al. (2001)	30	39.57	11.07	31.2	13.16	57	Yes	FAS
Libon et al. (1994)	23	49.5	16.0	69.7	13.4	35	Yes	CFL
	14	43.5	13.3	81.0	12.4	29	Yes	CFL
Lovejoy et al. (1999)	26	39.92	7.14	41	16	50	Yes	CFL
Monsch et al. (1992)	53	41.2	12.5	71.2	13.6	32	Yes	FAS
Munro et al. (2000)	17	45.18	14.14	66.94	13.27	53	Yes	FAS
Myers & Rohling (2004)	29	49.9	10.2	38.6	13.43	50	Yes	FAS

Study	N	Mean Score	SD	Mean Age	Mean Education	% Male	Strict Exclusion Criteria	Form
Nebes et al. (2002)	12	39.7	12.8	73.5	17.2		No	FAS
Norris et al. (1995)	54	36.9	10.1	73.1	16.7		No	FAS
	40	40.5	7.8	19.4	13.6		No	FAS
Nyberg et al. (1997)	39	42.51	9.77	77.3	13.6		No	FAS
Owens et al. (2002)	10	45.2	13.8	27.7	17.3	0	No	FAS
Rapport et al. (2001)	32	44.0	10.8	33.2	14.8	59	Yes	FAS
Riccio et al. (2005)	30	40.73	11.62	21.09	14.38	43.3	No	FAS
Rippeth et al. (2004)	60	40.1	9.6	34.4	13.2	50	No	FAS
Rockers et al. (1996)	88	39.8	9.6	21	14.3	50	No	FAS
Ross (2003)	125	38.1	7.9	20.1		31	Yes	CFL
Ross et al. (2005)	60	38.88	7.72	20.43		22	No	CFL
Rouleau et al. (2002)	5	51.8		73.8	13.2	20	Yes	FAS
	7	40.5		75.3	13.1	43	Yes	FAS
Royall et al. (2005)	547	32.0	12.6	77.9	15.1	41.7	No	CFL
Ruby (2000)	15	45.33	11.40	33.87	17.6	0	No	FAS
Ruff et al. (1986)	120	39.7		40.5	14.0	50	Yes	CFL
	240	40.3		40.4	14.2	50	Yes	CFL
Ryan et al. (1993)	67	42.64	10.50	35.3	13.8	31	Yes	FAS
Salthouse et al. (1996)	259	37.3		49.98	15	37	No	FAS
Saxton et al. (2000)	15	41.1	11.2	70.8	13.2	53	Yes	FAS
Selnes et al. (1991)	309	45.7	12.7	31.0	16.1	100	Yes	FAS
	290	46.1	12.6	39.3	16.4	100	Yes	FAS
	97	45.9	12.3	48.5	16.7	100	Yes	FAS
Simkins-Bullock et al. (1994)	19	43.58	9.63	52.6	15.6	53	Yes	FAS
Simon et al. (2000)	65	43.0	11.0	31	12.8	40	No	FAS
Spica (1995)	26	39.31	12.56	71.27	13.19	38	No	CFL
Stowe (1996)	16	38.2	13.0	25.7	13.2	38	Yes	FAS
Sumerall et al. (1997)	47	31	11.2	82.19	14.35	19	Yes	CFL
Suter (1997)	75	38.87	10.67	23.54	13.5	33	Yes	FAS
Svetina et al. (1999)	45	43.9	9.8	33	16.4		No	CFL
Thomason (1997)	30	35.97	12.12	66.92	13.82	33	No	FAS
Tombaugh et al. (1996)	12	38.5	12.0	37.5	7		Yes	FAS
	76	25.3	11.1	69.5	7		Yes	FAS
	75	22.4	8.2	87.5	7		Yes	FAS
	268	40.5	10.7	37.5	10.5		Yes	FAS
	292	35.6	12.5	69.5	10.5		Yes	FAS
	102	29.8	11.4	87.5	10.5		Yes	FAS
	242	44.7	11.2	37.5	17		Yes	FAS
	185	42.0	12.1	69.5	17		Yes	FAS
	46	37.0	11.2	87.5	17		Yes	FAS
Tomer & Levin (1993)	26	39.2	11.8	55	13.2		Yes	FAS

Study	N	Mean Score	SD	Mean Age	Mean Education	% Male	Strict Exclusion Criteria	Form
	39	38.7	11.3	70	13.4		Yes	FAS
	19	38.6	10.4	82	13.7		Yes	FAS
Troyer et al. (1997)	41	41.88	11.45	22.3	14.4	37	No	FAS
	54	41.26	10.9	73.3	13.2	50	No	FAS
Troyer et al. (1998)	38	40.8	9.6	73.8	12.6	63	Yes	FAS
	37	42.7	11.4	54.4	13.9	46	No	FAS
Vasudev (2000)	22	45.73	10.55	65.32	17.68	73	Yes	FAS
Westervelt (2000)	17	49.06	16.0	51.06	16.18	24	Yes	FAS
White et al. (1997)	15	50.3	7.2	37.7	14.5	100	No	FAS
Woods & Troster (2003)	18	37.11	16.2	68.76	14.18	67	Yes	FAS
Yuspeh (1994)	32	45.37	10.15	21.71	13.03		No	FAS
Zakzanis et al. (2000)	35	39.77	9.04	43.9	12.6	31	Yes	CFL
Zee et al. (1999)	45	36.6	13.1	63.1	13.6	24	Yes	FAS

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Table 1

Demographic Characteristics of the Sample

N	134
Mean Score (SD)	40.18 (6.02)
Mean Standard Deviation (SD)	11.23 (2.12)
Mean Age (SD)	53.63 (19.65)
Mean Education (SD)	13.94 (2.01)
Average % Male Participants (SD)	50% (31)

Table 2

Characteristics of Studies

Mean Age of Study	8.99 (4.36)
Number Employing Strict Exclusion Criteria	85
Number Using FAS Form	112

Table 3

Estimates for Demographic and Study Variables (Unstandardized Beta Weights)

Variable	Mean	Standard Deviation
Age	−0.093**	0.028**
Education	1.534**	0
% Male	0	0
Exclusion Criteria	3.274**	0
Age of Study	0	−1.242**
Form of Test	−2.401*	−0.113**

* $p<0.05$

** $p<0.01$

Table 4

Variance in Means Accounted for by Independent Variables

Variable	Mean	Standard Deviation
R^2	0.468	0.151
% R^2 accounted for by:		
Age	29.5	45.6
Education	54.3	
% Male		
Exclusion Criteria	13.5	
Age of Study		27.8
Form of Test	2.7	26.5

Magnitude of effect sizes: Small (1-2% of variance), Medium (5-10%), Large (15% or more).