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A comprehensive analysis of verbal fluency deficit in geriatric schizophrenia

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Abstract

Deficits in verbal fluency are common in schizophrenia and may provide keys to some of the abnormalities in the semantic system in schizophrenia. While a number of studies have outlined the severity and implications of verbal fluency deficits in younger schizophrenia patients, these findings have not yet been extended to older patients with schizophrenia. In this study, 392 older (age $\geq$ 50) patients with schizophrenia were administered phonological and semantic (i.e., category) fluency examinations, as well as tests of learning, memory, language, and praxic skills, and rated for clinical symptoms and functional status. When compared to normative standards, 82% of the patients were impaired in semantic fluency and 83% were impaired in phonological fluency. Both semantic and phonological fluency impairment were significantly correlated with other cognitive variables, total scores on the functional status measure, and with the social and self-care subscales. Scores were uncorrelated with the severity of psychosis, but were correlated with the severity of negative symptoms. Furthermore, the severity of poverty of speech (a clinical measure of verbal underproductivity) was moderate in magnitude and failed to enter as a predictor of verbal fluency, indicating that impaired fluency scores are not simply an artifact of general underproductivity or mutism. The findings support conclusions from studies with younger schizophrenia patients that suggest that verbal fluency impairment is a consequence of a disorganized semantic system. Verbal fluency impairment remains common and functionally relevant in schizophrenia patients in late life.

Keywords: Verbal fluency deficit; Schizophrenia; Semantic fluency; Phonological fluency

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1. Introduction

One of the most common neuropsychological deficits in schizophrenia is the ability to generate a series of words under conceptual or phonological demands, referred to as verbal fluency. Poor performance on verbal fluency tasks is a common sign in multiple neuropsychiatric conditions, including frontal lobe dysfunction, dementia, and depression (Lezak, 1995, p. 546). Impaired performance on fluency tasks may implicate a dysfunctional semantic system, which has also been suggested as a possible origin of formal thought disorder in schizophrenia (Goldberg et al., 1998). Impaired verbal fluency has been reported to be a correlate of reductions in the level of functioning of patients with schizophrenia (Green, Kern, Braff, & Mintz, 2000).

In neuropsychological assessment, verbal fluency is commonly assessed with phonological fluency and semantic (category) fluency tasks. The Controlled Oral Word Association Test (COWAT; Spreen & Strauss, 1998) is the most commonly employed measure of phonological fluency. In a typical version of this examination, the examinee is asked to name, in three consecutive trials lasting 1 min, as many words as he/she can that begin with a certain letter of the alphabet (e.g., F, A, and S). Animal naming is the most common measure of semantic fluency. In this version of the test, the examinee names as many different animals as he/she can in 60 s. Other versions may include other superordinate category relationships, such as supermarket items, tools, or articles of clothing. Good performance on these tasks depends on intact lexical storage and the ability to retrieve information from semantic memory. Lesions in the temporal and frontal regions (Crowe, 1992) of the brain and lesions in the left hemisphere (Benton, 1968) have been found to predict reductions in verbal fluency. Errors on fluency tasks include repetitions (also referred to as perseverations), which result from repeating the same word or word stem, and intrusions, which occur when the subject provides an inappropriate response (e.g., “car” in the animal naming task).

Examining the relationship between thought disorder, verbal fluency, and other cognitive functions could provide a means for evaluating the nature and correlates of verbal fluency deficits. The overall severity of formal thought disorder has been reported to be associated with reduced spontaneous verbal output and more errors in speech as well as reductions in performance on verbal fluency examinations (Kerns, Berenbaum, Barch, Banich, & Stolar, 1999). More specifically, Allen, Liddle, and Frith (1993) found that subtypes of thought disorder were associated with certain types of errors on verbal fluency tasks. Patients who evidenced incoherence of speech produced more intrusions and patients with poverty of speech terminated their performance prematurely, resulting in relatively more errors and fewer words generated, respectively (Allen et al., 1993). Like many of the cognitive deficits seen in schizophrenia, performance on verbal fluency tasks is related to negative symptoms, but not positive symptoms (Howanitz, Cicalese, & Harvey, 2000; Kerns et al., 1999). Schizophrenia patients with more negative symptoms have been found to generate fewer words, while non-specific features of the illness, such as depression, are often found to be unassociated with impaired verbal fluency (Allen et al., 1993).

Questions about the cause of the poor verbal fluency in schizophrenia remain, as some investigators argue that these deficits are a result of insufficient or inadequate storage or loss of information, while others argue for deficient retrieval processes based on impairments in

semantic structure. Kerns et al. (1999) present the case for insufficient storage based on the association between formal thought disorder and loss of semantic information. Studies that implicate a deficiency in the ability to efficiently retrieve semantic information from an adequate semantic store are based on evidence of structurally intact semantic memory in the context of impaired fluency (Allen et al., 1993; Joyce, Collinson, & Crichton, 1996). Goldberg et al. (1998) also found that while other measures of language were relatively intact, poor performance on tests sensitive to organization of the semantic system was associated with impaired verbal fluency. That is, while the amount or characteristics of information in storage may not be degraded, the ability to access that information is disrupted. Aloia, Gourovitch, Weinberger, and Goldberg (1996) attribute poor semantic fluency to a lack of organization and logical associations within the semantic networks of schizophrenia patients. This semantic disorganization may provide an explanation for relatively greater impairments in semantic fluency, compared to phonological fluency (Gourovitch, Goldberg, & Weinberger, 1996). In normal subjects, the typical pattern of performance includes more production with semantic than phonological demands (Rosen, 1980). Alzheimer's disease patients also show the pattern of relatively poorer semantic fluency and inability to benefit from semantic cues (Hodges, Salmon, & Butters, 1991), which may be specific to cortical as compared to subcortical dementia (Randolph, Braun, Goldberg, & Chase, 1993).

Examination of verbal fluency deficits in schizophrenia across different age ranges reveals systematic relationships between age and types of fluency deficits. Harvey, Lombardi, Leibman, and White, et al. (1997) found impairments in semantic fluency were comparable in both younger and older schizophrenia patients and correlated with the severity of other language abnormalities, while phonological fluency impairments worsened with age and were correlated with verbal memory capacity, implicating other deficits in information processing. These findings suggest dysfunctional storage as well as inefficient processing and retrieval account for fluency impairments; however, the deficits may express themselves differently depending on the age of the subject and the specific task used. Many older schizophrenic patients with poor outcome and a chronic course of illness demonstrate severe impairments in cognitive functioning, with performance deficits superficially similar to patients with dementia (Davidson et al., 1995; Friedman et al., 2001; Harvey et al., 1999). However, this decline in functioning is not associated with known dementing illnesses at post-mortem neuropathological examination (Powchik et al., 1998; Purohit et al., 1998).

While the existing literature has characterized the nature and meaning of verbal fluency deficits in schizophrenia, most studies are limited to samples of younger subjects (e.g., all under the age of 50). Questions regarding the nature and correlates of verbal fluency in geriatric schizophrenic patients remain. The present study seeks to comprehensively evaluate verbal fluency performance in an older, cognitively impaired sample and to re-examine a number of the previous findings in a single, substantial sample of patients. The association of positive symptoms, negative symptoms, and thought disorder with verbal fluency performance will be examined across two different versions of the verbal fluency examination, category and phonological fluency. The present study will attempt to clarify the issue of whether verbal fluency impairments in schizophrenia are related to other aspects of cognitive deficit or if they can be fully explained by the severity of thought disorder or negative symptoms. Further, the present study will examine the association between verbal fluency deficits and functional impairment

in this population, by correlating performance on verbal fluency tasks with measures of functional outcome, examining whether fluency has a unique role in the prediction of functional outcome of whether other symptoms or cognitive impairments (e.g., in declarative memory) are more important.

2. Method

2.1. Participants

All patients included in this study were participants in a large-scale program of research on cognitive functioning and clinical symptoms in geriatric chronic psychiatric patients. At the outset of this study, the entire population of a state psychiatric center was re-diagnosed and re-evaluated with a comprehensive assessment of clinical, cognitive, and functional status (Davidson et al., 1995). Later expansions of the subject samples included inpatients and outpatients at three different VA hospitals and several different large nursing homes. All patients at all sites assented to participate; the Institutional Review Boards at Pilgrim Psychiatric Center, the Mount Sinai School of Medicine, and the VA hospitals approved a waiver of a signed informed consent. Research staff members performed diagnostic assessments and a structured consensus procedure was employed in order to generate DSM-III–R diagnosis of schizophrenia. The entire assessment procedure for that study has been published and all subjects in this study were diagnosed and assessed with that procedure (Davidson et al., 1995; Harvey et al., 1998). The participants in this study are a subsample of this large database, which has been the basis for a number of published studies.

For the present study, patients were selected from the larger database if they had a diagnosis of schizophrenia, had a Mini-Mental State Examination score of at least 18 (seen to reflect moderate impairment when screening for dementia; see Welsh, Butters, Hughes, Mohs, and Heyman (1991) for an example), and were able to provide responses to phonological and semantic fluency tasks (i.e., they offered a response). Potential participants were excluded from this study if they were in active treatment for a seizure disorder, had a previous cerebral vascular accident, a prior diagnosis of alcohol/drug dependence, head trauma with loss of consciousness, or Pervasive Developmental Disorder, mental retardation, neurological diseases or damage, or other psychiatric diagnoses. Patients were also excluded if their current overall Clinical Dementia Rating (Hughes, Berg, Danziger, Cobin, & Martin, 1982) was greater than 3 (indicating the patient could no longer use or understand language adequately, recognize even close family members, or they require total care). All patients received an annual physical and neurological examination. In order to exclude patients with newly incident dementing conditions, any patient who a neurologist determined, on the basis of a scheduled annual clinical evaluation, had experienced "rapid cognitive decline" in the past year was also excluded. Previous research by our group has revealed low prevalence of Alzheimer's disease or other dementias on post-mortem examination (about 10%; Powchik et al., 1998; Purohit et al., 1998); the above exclusion criteria are intended to reduce the possibility of including patients with dementia. From a total database of 1,574 patients, 392 met all of these criteria and had all of the data described below available as well.

2.2. Assessments

2.2.1. Negative and positive symptoms

Severity of schizophrenic symptoms was assessed using the Positive and Negative Syndrome scale (PANSS). This is a 30-item scale with 7 items measuring positive symptoms, 7 items measuring negative symptoms, and 16 items measuring general aspects of psychopathology (Kay, 1991). The total scores on positive, negative, and general psychopathology subscales were variables in this study. Inter-rater reliability of these ratings in our patients was previously found (Davidson et al., 1995) to be acceptably high, with IntraClass Correlations ($n = 30$) ranging from a low of .86 to a high of 1.00 (all Ps $< .001$).

2.2.2. Cognitive functioning

2.2.2.1. CERAD cognitive battery. This brief neuropsychological assessment battery was developed for the diagnosis and staging of Alzheimer's disease (Morris et al., 1989). As a result, it measures several crucial cognitive impairments that are present in dementia. Previous research with this battery has demonstrated that Alzheimer's disease patients can be discriminated from patients with schizophrenia on a cross-sectional basis (Davidson et al., 1995). Additional studies with the CERAD battery demonstrated that schizophrenic patients have high test-retest stability coefficients and do not decline as a group at a 1-year follow-up on any of the measures in the battery (Harvey, Lombardi, Leibman, & White, et al., 1997). In this study, the CERAD battery was supplemented by the inclusion of phonological fluency, in order to broaden the assessment of verbal fluency performance.

1. *Word list learning and delayed recall*. A ten-item list of words was presented to the subject on three separate learning trials. After each trial, free recall of the list was required of the subjects. After a delay, filled by the Praxic drawings described below, a delayed recall of the word list was required, as well as a recognition task. The dependent variables were the total number of words correctly recalled over the three learning trials, and the number of words recalled at the delayed recall.
2. *Praxic drawings*. Four drawings (circle, diamond, overlapping rectangles, cube) were presented to the subject, who was instructed to copy them exactly. Reproductions were scored according to predetermined criteria and the dependent measure was the total score for the 4 drawings.
3. *Modified Boston Naming Test*. Subjects were presented with 15 line drawings and asked to name the object depicted. The drawings consisted of five objects with high frequency of occurrence in spoken English, five of moderate frequency, and five of low frequency. The dependent variable was the total number of correct namings.
4. *Semantic (category) fluency*. Subjects were instructed to name as many different animals as possible in 1 min. The dependent variable is the number of unique animals named.
5. *Phonological fluency.* Subjects were instructed to name as many words beginning with a certain letter (F, A, and S) as they could in 1 min, while not naming proper nouns or repeating word stems. This measure was added as a supplement to the CERAD battery in order to more comprehensively examine verbal fluency performance.

To obtain an estimate of premorbid intellectual functioning, the Wide-Range Achievement Test—Revised (WRAT–R; Jastrak, 1984) word recognition reading subtest was administered as a measure of putative premorbid academic competence. The dependent measure was the total score.

2.2.3. Scale for the assessment of thought, language and communication (TLC)

This scale was developed to aid in the assessment of formal thought disorder by providing standard definitions for terms frequently used to describe language and cognitive abnormalities, such as poverty of speech, tangentiality, word approximations, and perseveration, as well as a global rating of the overall severity, with more pathological disorders (e.g., poverty of speech, tangentiality) weighted more than less pathological disorders (e.g., circumstantiality, stilted speech; Andreasen, 1986). Ratings range from 0 (none) to 4 (extreme) and are based on examiner's interaction with the subject. Previous research in this project (Harvey, Lombardi, Leibman, Parrella, White, Powchick, Mohs, & Davis, 1997) documented the inter-rater reliability of this scale in this population.

2.2.4. Social Adaptive Functioning Evaluation (SAFE) scale

This 17-item scale was developed by the current investigators (Harvey, Davidson, et al., 1997) and measures social-interpersonal, instrumental, and impulse-control deficits. This scale was designed to be rated on geriatric patients living in an inpatient facility after observation of and interaction with the subject, as well as a caregiver interview and chart review. Previous research with this scale found that both social and instrumental skills deficits were related to cognitive impairments, while deficits on the impulse control subscale were not (Harvey, Sukhodolky, Parrella, White, & Davidson, 1997). This scale has suitable reliability, with inter-rater reliabilities of the items all exceeding 0.88 (ICC, $n = 60$). The total score is used as the primary dependent measure; measures of self-care ability, social functioning, and impulse control were also derived through previously validated subscales of the measure.

3. Results

3.1. Descriptive statistics

In this sample of geriatric schizophrenia patients, 45% (176) were male and 55% (216) were female. At the time of assessment, 63 patients resided in a Veteran's Affairs Hospital, 103 patients were former inpatients who had recently been discharged to a nursing home, and 226 were institutionalized patients at a state psychiatric facility. Some of these evaluations were done prior to the inclusion of the SAFE scale in the study. Therefore, not all assessments generated scores for all measures. Data analyses were performed with missing data deleted on a casewise basis. See Table 1 for descriptive statistics and test performance scores and Table 2 for correlations between the two fluency tasks and cognitive, symptom, and social-adaptive functioning variables.

All patients were individually classified according to norms in Spreen and Strauss (1998) into levels of verbal fluency impairment based on their age and level of education. When

Table 1
Descriptive statistics for the entire sample

	Mean (S.D.)	Minimum	Maximum
Demographics			
Age	72.3 (8.29)	50	93
Years of education	11.0 (2.78)	3	19
Age at first hospitalization	27.8 (9.63)	7	75
Symptomatology			
Positive symptoms	18.9 (5.85)	7	39
Negative symptoms	22.8 (7.31)	8	44
General symptoms	41.5 (9.25)	16	73
Cognitive variables			
Phonological fluency	14.17 (10.11)	1	57
Semantic fluency	8.29 (4.61)	1	27
WRAT reading score	48.9 (20.23)	1	100
Modified Boston Naming Test	11.4 (2.83)	0	15
Praxis total	6.37 (2.85)	0	11
Word list Trials 1–3 total	11.4 (5.99)	0	30
Word List Delayed Recall	2.5 (2.36)	0	10
SAFE variables			
Instrumental self-care	13.8 (7.19)	0	31
Impulse control	3.1 (2.38)	0	11
Social functioning	11.5 (5.81)	0	26
SAFE total	28.5 (12.57)	0	54

Note. Higher scores reflect greater impairment on the SAFE scale.

Table 2
Correlation of phonological and semantic fluency with cognitive, symptom, and social-adaptive functioning variables

	Phonological	Semantic	BOSTOT	PXTOT	WLTOT	WLRCL	POSSX	NEGSX
Phonological	1.00	0.70*	0.45*	0.45*	0.57*	0.53*	0.06	−0.40*
Semantic	0.70*	1.00	0.45*	0.45*	0.54*	0.49*	0.05	−0.36*
INSTR	−0.47*	−0.47*	−0.38*	−0.36*	−0.34*	−0.39*	0.07	0.50*
IMPCNTRL	−0.12	−0.16*	−0.11	−0.14*	−0.07	−0.05	0.30*	0.20*
SOCFX	−0.39*	−0.39*	−0.24*	−0.31*	−0.35*	−0.26*	0.22*	0.74*
SAFETOT	−0.47*	−0.48*	−0.35*	−0.38*	−0.37*	−0.35*	0.20*	0.66*
POV	−0.35*	−0.27*	−0.25*	−0.17*	−0.26*	−0.19*	−0.16*	0.63*
POC	−0.26*	−0.21*	−0.28*	−0.26*	−0.21*	−0.15*	0.21*	0.27*
TLC	−0.18*	−0.08	−0.11	−0.17*	−0.14*	−0.10	0.41*	0.20*

Note. BOSTOT: total score on the modified Boston Naming Test. PXTOT: total score on the Praxis test. WLTOT: total number of words on the Word List Learning test. WLRCL: number of correct responses on the Word List Delayed Recall test. POSSX: total score of the positive symptoms subscale of the PANSS. NEGSX: total score of the negative symptoms subscale of the PANSS. INSTR: score on the Instrumental Social Skills scale of the SAFE. IMPCNTRL: score on the Impulse Control scale of the SAFE. SOCFX: score on the Social Functioning scale of the SAFE. SAFETOT: total score on the SAFE. POV: poverty of speech score from the TLC. POC: poverty of content of speech from the TLC. TLC: total score from the TLC.

* $P < .05$.

Table 3
Percentage of patients in each level of verbal fluency impairment

	Intact	Moderately impaired	Severely impaired
Fluency test			
Phonological	16.68	41.56	41.56
Semantic	17.77	30.42	51.80

Note. Intact: within 1 S.D. of the mean. Moderately impaired: between 1 and 2 S.D. below mean. Severely impaired: 2 or more S.D. below mean.

education level could not be verified by chart review or informant interview ($N = 45$), the patient was classified according to norms based solely on age for the semantic fluency test and for the 9–12 years of education group for the phonological fluency, as these were available. See Table 3 for the number of patients in each group.

3.2. Correlates of verbal fluency performance

As demonstrated in Table 2, phonological and semantic fluency scores were strongly correlated with each other and correlated to a lesser extent with all other cognitive variables. These two scores were associated with negative symptoms, but unassociated with positive symptoms. Social functioning was also correlated with both fluency measures. Notably, the magnitude of these correlations was nearly identical for phonological and semantic fluency.

Significantly more patients were impaired (greater than 1 standard deviation below the mean) than intact in phonological and semantic fluency ($\phi^2 < 0.001$). Table 3 displays the distribution of patients across three levels of impairment.

3.3. Comparisons across level of verbal fluency impairment

Multivariate analyses of co-variance (MANCOVAs) were used to compare symptom, cognitive, and social-adaptive functioning variables across the intact and impaired fluency groups. The total score on the WRAT Recognition Reading subtest was used as a covariate to consider the effects of putative premorbid functioning. The groups were divided with a cutoff of 1 and 2 standard deviations below the mean on the semantic fluency task. This resulted in three comparison groups: (1) patients with intact verbal fluency (within 1 standard deviation of the mean), (2) patients with moderately impaired verbal fluency (between 1.01 and 2.0 standard deviations below the mean), and (3) patients with severely impaired verbal fluency (2.01 or more standard deviations below the mean). Since the number of subjects completing portions of the evaluation differed, MANCOVAs were performed separately for cognitive tests, PANSS subscales, TLC items, and SAFE scales. These analyses were followed by post hoc comparisons using the Tukey HSD for unequal sample sizes test, as there was a large difference in the number of patients per group.

A MANCOVA comparing the intact, moderately impaired, and severely impaired groups on the cognitive tests was statistically significant, Wilks' Lambda $= 0.78$, Rao's $R(8, 616) = 9.72$, $P < .001$. The severely impaired patients performed more poorly than the intact and moderately patients on each of the cognitive tests, while the moderately impaired patients

performed worse than the intact group on total learning. The MANCOVA comparing the groups on the symptom variables was statistically significant, Wilks' Lambda = 0.93, Rao's $R(4, 620) = 6.21$, $P < .001$. The severely impaired group evidenced more negative symptoms and more poverty of speech than the intact and moderately impaired groups. The MANCOVA comparing the subscales of the SAFE was statistically significant, Wilks' Lambda = 0.89, Rao's $R(6, 460) = 4.50$, $P < .001$. The severely impaired group evidenced poorer instrumental self-care, social functioning, and overall social-adaptive functioning than the intact and moderately impaired groups. All findings remained significant with WRAT reading recognition entered as a covariate. (See Table 4 for corrected F values and post hoc comparisons.)

3.4. Predictors of verbal fluency performance

Regression analyses were conducted to determine the contribution of cognition, negative symptoms, and thought disorder to predicting performance on the two verbal fluency tasks. Independent variables in these analyses were total number of words from the modified Boston Naming Test; total score on the praxis test; total number of words learned on the three learning

Table 4
Means, standard deviations, and analysis of covariance results for symptom, thought disorder, cognitive and social adaptive functioning variables

	Mean (S.D.)				
	Intact	Moderately impaired	Severely impaired	F	P
Symptomatology					
Positive symptoms	18.3 (6.83)	19.4 (6.33)	18.9 (5.25)	0.507	.602
Negative symptoms	19.4 (6.35)	21.1 (6.37)	24.7 (7.42)	12.03	<.001[a]
Thought disorder					
Poverty of speech	0.48 (0.86)	0.84 (1.05)	1.31 (1.5)	9.45	<.001[a]
Poverty of content	0.75 (0.97)	0.76 (1.08)	1.11 (1.2)	1.81	.166
TLC scale total score	6.48 (7.11)	7.65 (6.11)	7.85 (6.5)	0.412	.662
Cognitive variables					
Modified Boston Naming Test	13.0 (2.51)	11.91 (2.60)	10.63 (2.76)	8.43	<.001[a]
Praxis total	8.1 (2.37)	7.1 (2.65)	5.4 (2.71)	14.88	<.001[a]
Word list Trials 1–3 total	15.8 (5.03)	13.39 (5.47)	8.89 (5.26)	33.64	<.001[a,b]
Word List Delayed Recall	3.96 (2.81)	3.19 (2.26)	1.73 (1.91)	19.55	<.001[a]
SAFE variables					
Instrumental self-care	10.3 (7.63)	12.45 (6.59)	15.63 (6.83)	8.46	<.001[a]
Impulse control	2.5 (2.09)	3.1 (2.14)	3.3 (2.55)	1.32	.268
Social functioning	8.6 (5.65)	10.1 (5.35)	13.2 (5.55)	11.48	<.001[a]
SAFE total	21.5 (12.63)	25.6 (11.36)	32.3 (11.89)	12.20	<.001[a]

Note. Intact: within 1 S.D. of the mean. Moderately impaired: between 1 and 2 S.D. below mean. Severely impaired: 2 or more S.D. below mean. F values are the univariate corrected F statistics for the MANCOVA.

[a] Severely impaired > moderately impaired and intact.

[b] Moderately impaired > intact.

trials of the word list task; number of words recalled on the Word List Delayed Recall condition; the total score from the negative symptom scale of the PANSS; poverty of speech and poverty of content of speech from the TLC scale; and the total score from the TLC. Simultaneous entry regressions were first performed to determine if all of the cognitive, symptom, and thought disorder variables significantly accounted for the variance in either phonological or semantic fluency. If a significant effect was found, a forward entry stepwise regression was performed to identify the hierarchy of specific predictors. First, analyses were conducted using the entire sample. The analyses were then repeated in the patients with impaired phonological or semantic fluency (i.e., those patients who scored at least 1 standard deviation below the mean for their age and education level).

For the entire sample, the simultaneous regression analysis was significant for both phonological fluency, $F(8, 245) = 27.05$, $P < .001$, and semantic fluency, $F(8, 245) = 22.345$, $P < .001$. Forward entry regression analysis of phonological fluency was significant, $F(8, 245) = 28.27$, $P < .001$, with verbal learning ($R^2 = .333$), negative symptoms (R^2 change $= .073$), and praxis (R^2 change $= .038$) entering the model at the $P < .05$ significance level. Forward entry regression was also significant for semantic fluency, $F(6, 247) = 29.84$, $P < .001$, with learning ($R^2 = .292$), praxis (R^2 change $= .073$), and negative symptoms (R^2 change $= .034$) again entering the model as significant predictors at the $P < .05$ significance level. The following variables did not enter the regression: positive symptoms, poverty of speech, poverty of content of speech, Boston Naming, and delayed verbal memory.

Simultaneous regression analyses of patients with impaired verbal fluency were significant for both phonological, $F(8, 203) = 20.336$, $P < .001$ and semantic, $F(8, 200) = 19.431$, $P < .001$, fluency. Forward entry regression analysis of phonological fluency was significant in this group, $F(7, 204) = 23.34$, $P < .001$, with verbal learning ($R^2 = .263$), negative symptoms (R^2 change $= .091$) and praxis (R^2 change $= .056$) entering the model at the $P < .05$ significance level. Forward entry regression analysis of semantic fluency was also significant, $F(6, 202) = 26.047$, $P < .001$, with verbal learning ($R^2 = .279$), praxis (R^2 change $= .075$) and negative symptoms (R^2 change $= .046$) entering the model at the $P < .05$ significance level. As with the analysis of the entire sample, the following variables again did not enter the regression: positive symptoms, poverty of speech, poverty of content of speech, Boston Naming, and delayed verbal memory.

An additional regression analysis was conducted to determine what if any variables contributed to deficits in semantic fluency other than phonological fluency scores. Simultaneous regression analysis was significant, $F(11, 242) = 31.07$, $P < .001$. Forward entry regression analysis was also significant, $F(5, 248) = 68.83$, $P < .001$, with phonological fluency ($R^2 = .529$) accounting for most of the variance, and praxis (R^2 change $= .023$), verbal learning (R^2 change $= .014$), and the TLC total score (R^2 change $= .01$) entering the model at the $P < .05$ significance level.

3.5. Predictors of symptoms and social-adaptive functioning

The following analyses were conducted to determine which, if any, cognitive tests predicted positive and negative symptomatology from the PANSS, TLC items, and cognitive variables in functional status, as measured by the SAFE scale.

As above, simultaneous entry regression was followed by forward entry stepwise regression to examine specific predictors. The cognitive variables were phonological fluency, semantic fluency, total score from the modified Boston Naming Test, the WRAT Recognition Reading subtest total score (WRAT), total score on the praxis test, total number of words learned on the three trials of the word list task, and number of words recalled on the Word List Delayed Recall condition. These analyses included all patients with valid SAFE scale scores ($n = 249$).

The cognitive variables did not significantly predict positive symptoms, $F(7, 366) = 1.01$, $P = .418$. However, simultaneous regression analysis found the cognitive variables to predict negative symptoms, $F(7, 366) = 30.598$, $P < .001$. Forward entry regression, $F(4, 368) = 45.91$, $P < .001$, found phonological fluency ($R^2 = .294$) and learning (R^2 change $= .027$) to be significant predictors of negative symptoms.

The cognitive variables significantly predicted rating of poverty of speech, $F(7, 246) = 7.47$, $P < .001$. Forward entry regression, $F(4, 249) = 12.83$, $P < .001$, found only phonological fluency ($R^2 = .154$) to enter the regression as a significant predictor of poverty of speech. The cognitive variables did not significantly predict the global rating of thought disorder, $F(7, 246) = 1.36$, $P = .218$.

The cognitive variables significantly predicted ratings on the Instrumental Social Skills scale from the SAFE, $F(7, 267) = 19.22$, $P < .001$. Forward entry regression, $F(4, 269) = 28.712$, $P < .001$, found phonological fluency ($R^2 = .239$) and delayed verbal memory (R^2 change $= .032$) to enter the model at the $P < .001$ significance level. Cognitive variables did not significantly predict ratings on the Impulse Control scale, $F(7, 267) = 2.727$, $P = .013$. However, they did predict ratings on the Social Functioning scale, $F(7, 267) = 16.82$, $P < .001$. Forward entry regression, $F(5, 268) = 20.64$, $P < .001$, found phonological fluency ($R^2 = .223$) and learning (R^2 change $= .031$) to enter as significant predictors of social functioning. Standard regression found that the cognitive variables predicted the total score on the SAFE, $F(7, 267) = 21.63$, $P < .001$. Forward entry regressions, $F(4, 269) = 32.43$, $P < .001$, found only phonological fluency ($R^2 = .267$) and semantic fluency (R^2 change $= .035$) of the cognitive variables to predict the SAFE total score.

4. Discussion

The goal of the present study was to provide a comprehensive analysis of the nature and significance of verbal fluency deficits in geriatric schizophrenia. Results offer support for previous findings, extend previous results to an older, more cognitively impaired sample, and provide new data to clarify the specific role of verbal fluency in functional status.

The results of the study indicate that most geriatric schizophrenia patients with a history of relatively poor lifetime outcome are likely to demonstrate impairments on tests of verbal fluency, when normative standards considering their age and educational attainment are employed. The proportion of patients showing impairment is similar to rates found in previous studies of younger schizophrenia outpatients (Palmer et al., 1997). Similarly, the proportion of patients who performed in the average range was similar to the proportion of patients in the Palmer et al.'s study. It is possible that the patients in this study who demonstrated intact fluency were actually "neuropsychologically normal" throughout their entire course of the

illness. Patients with severely impaired verbal fluency performance were more impaired in tests of learning, memory, language, and praxis, and more functionally impaired than patients with intact or moderately impaired verbal fluency, while the influence of premorbid reading scores did not account for these differences between the groups.

The present study has several limitations that should be considered. Findings from the study of older, chronically ill patients may not generalize to younger or more acutely ill patients. However, there exists a large literature base describing verbal fluency in schizophrenia, and the results of the present study complement those findings to broaden our understanding of the role of verbal fluency deficits across the age-range. The battery of cognitive tests used in this study, though comprehensive, does not assess some functions that may also contribute to functional status (e.g., tests of "executive functioning"). More comprehensive batteries may change the pattern of predictors and correlates. However, this sample of older, more cognitively impaired schizophrenia patients may perform below the floors of the tests of executive function, which are more difficult than tests in the CERAD battery. While other phonological and semantic fluency tasks exist, phonological fluency tests are highly correlated with each other (Lacy, Gore, Pliskin, & Henry, 1996), making it unlikely that they would substantially alter the findings. The equivalence of different categories has not yet been established; it is possible that examination of other superordinate categories may broaden the findings (Spreen & Strauss, 1998). Finally, measures of the intactness of the semantic system were not included in this study, which would be critical in order to truly discriminate whether differences in semantic functioning were differentially associated with these two types of fluency.

In contrast to our previous study with a small sample of subjects that found differential associations with fluency tasks based on the age of the subject (Harvey, Lombardi, Leibman, Parrella, White, Powchick, Mohs, & Davidson, 1997), minimal differences in predictors of fluency performance were found. Negative symptoms were associated with performance on phonological and semantic fluency tasks, but to a lesser extent than cognitive deficits, while poverty of speech scores did not have a substantial association with verbal fluency when other variables were considered. These findings indicate that impaired verbal fluency is likely to be a result of cognitive factors, rather than negative symptoms such as apathy or avolition. Moreover, the findings do not implicate a specific verbal factor, as praxis scores were highly correlated with phonological and semantic fluency and account for a significant portion of the variance in semantic fluency scores. It must be noted, however, that these correlates, while statistically significant, often did not account for a large portion of the variance.

The importance of cognitive functioning in schizophrenia is demonstrated with its relationship to outcome and social functioning (Green, 1996; Harvey et al., 1998). It is notable that verbal fluency appears to have a unique role among cognitive variables in predicting social-adaptive functioning in hospitalized geriatric schizophrenia patients. Phonological and semantic fluency were clearly linked to functional status, even more so than verbal memory, which is also an important predictor. As a contributor to functional status, verbal fluency should be considered a target when planning intervention for cognitive deficits. Atypical antipsychotic medications appear to improve verbal fluency more than other cognitive functions, but this remediation does not always normalize performance (Harvey & Keefe, 2001). Previous research has found that even when schizophrenia patients demonstrate profound cognitive impairment (MMSE scores <10), performance on cognitive measures is related to functional status (Bowie

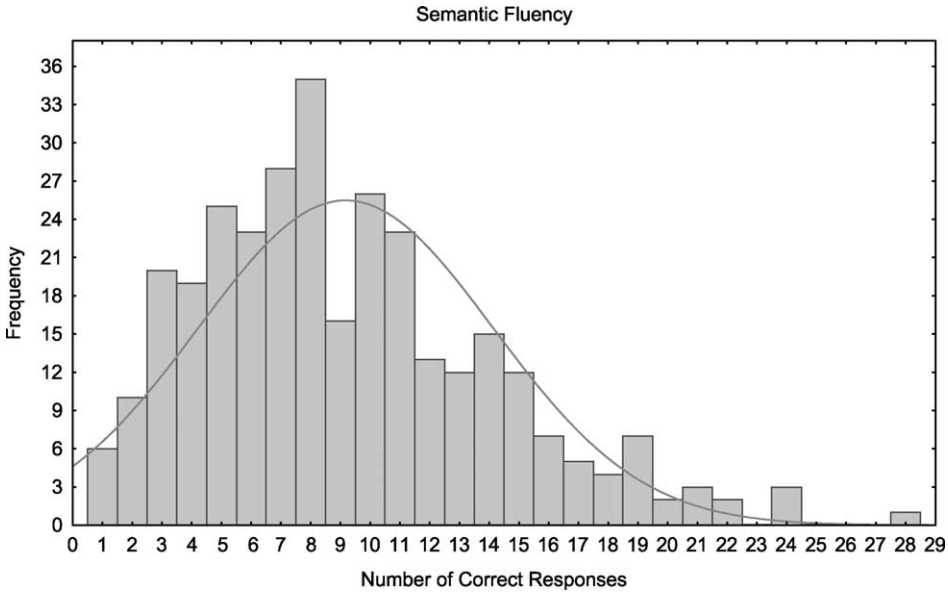

Fig. 1. Frequency of correct responses on the semantic fluency task (animal naming).

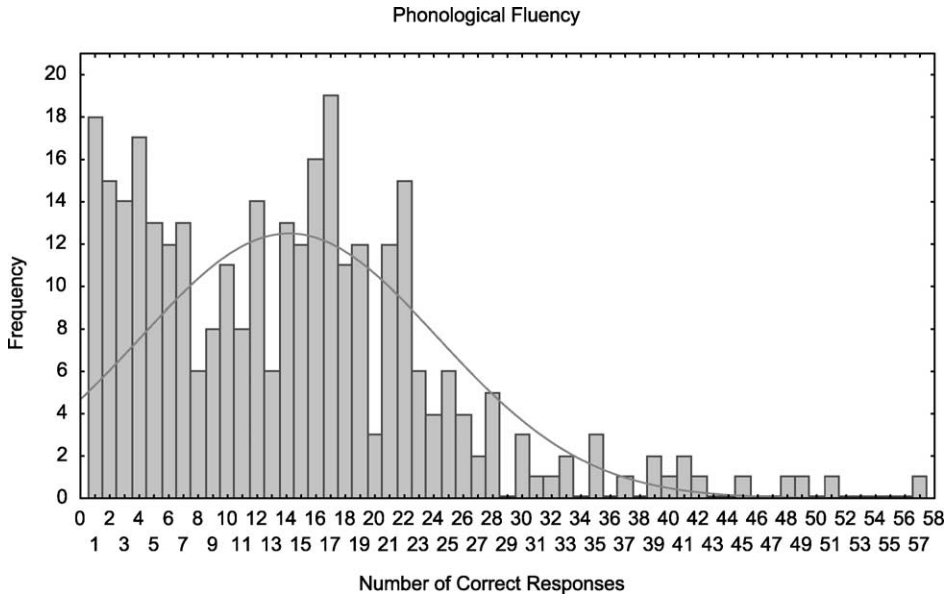

Fig. 2. Frequency of correct responses on the phonological fluency task (FAS).

et al., 2002). It is not clear that fluency would be predictive of functional status in patients who are this impaired. More research is needed to understand the possibility of improving verbal fluency and what benefits may result, as well as the parameters of global cognitive impairment within which fluency is predictive of functional outcome (Figs. 1 and 2).

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