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Fluency Performance Patterns in Alzheimer's Disease and Parkinson's Disease*

Rosemary Fama[1], Edith V. Sullivan[1], Paula K. Shear[1], Deborah A. Cahn-Weiner[1], Jerome A. Yesavage[1,2], Jared R. Tinklenberg[1,2], and Adolf Pfefferbaum[1,3]
[1]Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, CA, [2]Psychiatry Service, VA Palo Alto Health Care System, CA, and [3]Neuropsychiatry Program, SRI International, Menlo Park, CA

ABSTRACT

This study compared 38 patients with Alzheimer's disease, 20 patients with Parkinson's disease, and 51 normal controls on nonverbal, semantic, and phonological fluency tasks. Semantic and nonverbal fluencies declined significantly with age. The AD group was impaired on all fluency measures, with the greatest impairments on nonverbal and semantic fluency. The PD group was impaired on nonverbal and semantic fluencies. Differences observed in semantic fluency between the AD and PD groups could not be accounted for by dementia severity. Motor disability did not account for the PD nonverbal fluency deficit. This study provides evidence for a semantic-based impairment in AD and suggests that PD fluency deficits are primarily cognitive rather than motor in nature.

Fluency tests are often used in the neuropsychological evaluation of dementing illnesses (Monsch et al., 1992). Differences between diagnostic groups in fluency ability have been related to different underlying neural and processing mechanisms. Patients with Alzheimer's disease (AD) typically demonstrate a greater impairment on category fluency than phonological fluency (Butters, Granholm, Salmon, Grant, & Wolfe, 1987; Martin & Fedio, 1983; Mickanin, Grossman, Onishi, Auriacombe, & Clark, 1994; Monsch et al., 1992), while patients with Huntington's disease (HD) demonstrate uniform levels of impairment across semantic and phonological fluency tasks (Butters et al., 1987). The greater deficit in semantic than phonological fluency in AD has been attributed to an underlying breakdown in semantic knowledge, while the generalized verbal fluency impairment observed in HD has been attributed to impairment in initiation and retrieval mechanisms (Butters et al., 1987; Monsch et al., 1994; Rosser & Hodges, 1994). These hypothesized mechanisms are consistent with the neuropathology of AD and HD. The primary neuropathology of AD affects medial temporal and cortical areas, including the temporal neocortices, which are particularly important in the mediation of semantic knowledge (Rosser & Hodges, 1994), while the primary HD neuropathology affects subcortical areas, specifically striato-frontal systems, which are important in initiation and retrieval of information.

Although several studies have contrasted the fluency performance of patients with AD and

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Address correspondence to: Edith V. Sullivan, Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine (MC5717), Stanford, CA 94305-5717, USA. E-mail: edie@leland.stanford.edu.
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HD, fewer reports on fluency performance in Parkinson's disease (PD) are available and a number of existing reports on the pattern and extent of verbal fluency deficits in PD have been inconsistent (for reviews see Azuma et al., 1997; Lezak, 1995). Some reports cite greater deficits on phonological than semantic fluency (Bayles, Trosset, Tomoeda, Montgomery, & Wilson, 1993), whereas others report the opposite pattern (Auriacombe et al., 1993; Beatty, Staton, Weir, Monson, & Whitaker, 1989; Raskin, Sliwinski, & Borod, 1992), and still others report comparable impairments in semantic and phonological fluency (Gurd & Ward, 1989) or no verbal fluency impairment at all (Hanley, Dewick, Davies, Playfer, & Turnbull, 1990).

Studies of fluency abilities in dementing disorders have typically focused on the verbal domain. Little has been reported about relative differences between verbal and nonverbal fluency performance in different dementing illnesses. Nonverbal fluency tasks, like verbal fluency tasks, require speeded and rule-driven generation of exemplars from predetermined categories. Depending on the specific task demands, nonverbal fluency tasks have been thought to be either an analogue of phonological fluency (e.g., design fluency: Jones-Gotman & Milner, 1977; Ruff, Light, & Evans, 1987) or semantic fluency (e.g., nonverbal task of Grossman: Grossman, 1988). Comparison of verbal and nonverbal fluency could elucidate whether fluency deficits reflect simply a generalized deficit in speeded retrieval or, alternatively, whether verbal and nonverbal fluencies tap different processing domains and contributing pathology in dementing diseases. Nonverbal fluency deficits have generally been associated with frontal lesions of the right hemisphere (Jones-Gotman & Milner, 1977; Ruff, 1988), yet left frontal lesions can also disrupt design fluency (Jones-Gotman & Milner, 1977). Although nonverbal fluency deficits occur in AD (Bigler et al., 1988; Mickanin et al., 1994), the results are again equivocal in PD, with some studies reporting deficits (Taylor, Saint-Cyr, & Lang, 1986) and others reporting no significant impairment (Auriacombe et al., 1993).

Age, education, and dementia severity have all been associated with performance on various fluency measures (Fischer, Gatterer, Marterer, & Danielczyk, 1988; Lezak, 1995; Ober, Dronkers, Koss, Delis, & Friedland, 1986; Sagar & Sullivan, 1988; Tröster, Salmon, McCullough, & Butters, 1989). Differences in pattern of fluency performance between different neurodegenerative conditions may simply be related to the influence of these moderating variables rather than to disease-specific processes. Additionally, motor deficits may contribute significantly to fluency output, particularly in PD, because of the fundamental requirement of speeded output. Although verbal fluency performance in PD was not strongly associated with speed of recitation of automatic sequences (days of the week) and therefore is more reflective of an underlying cognitive process than motor speech disruption (Gurd & Ward, 1989) , it is unknown whether degree of PD motor disability is related to nonverbal fluency performance. If there is a relation between degree of PD motor disability and nonverbal fluency performance, then all or part of nonverbal fluency deficits if observed in the PD group may be explained by motor rather than cognitive factors.

The present study investigated the extent and pattern of verbal and nonverbal fluency performance in AD and PD. Direct comparisons between verbal and nonverbal fluency abilities within each group should provide information about whether fluency impairments are specific to a particular cognitive process (e.g., semantic knowledge) or are generalized across modalities. If nonverbal fluency, as measured by the Ruff Figural Fluency Test (Ruff, 1988), is a nonverbal analogue to phonological fluency, then nonverbal fluency performance should be more closely reflective of phonological than semantic fluency performance. Based on published findings, we expected that although the AD group would be impaired on verbal and nonverbal fluency tests, semantic fluency would be relatively more impaired than either phonological or nonverbal fluency. If generalized retrieval deficits underlie the PD deficits, possibly because of basal ganglia dysfunction, then we would expect that fluency deficits would be present and equiv-

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[a] NART.
[b] *T* test, $p \leq .05$

alent across semantic, phonological, and nonverbal fluency tasks in PD. In addition to overall fluency scores, we assessed generation of responses on verbal fluency trials across consecutive time epochs to examine differences between semantic and phonological fluency conditions within and between groups over time. This analysis permitted examination of whether output generation deficits were consistent throughout a trial, or whether a fluency deficit would be magnified later within a trial and after the initial pool of candidate words, available, for example, from such sources as frequently and recently encountered words, had been reduced. The potential influence of disease-related disabilities of motor impairment (finger rigidity and ideomotor apraxia) on fluency performance was examined to ensure that group differences on fluency performance, in particular nonverbal fluency performance, were not primarily due to simple motor or psychomotor deficits. Finally, we examined whether overall dementia severity per se could account for differences between the AD and PD groups on fluency abilities.

METHODS

Participants

Participants in this study included 38 patients with AD, 20 patients with PD, and 51 normal controls (NC). The AD patients (aged 55 to 84 years) were recruited from the Geriatric Psychiatry Rehabilitation Unit and the National Institute of Mental Health Aging Clinical Research Center, both housed at the VA Palo Alto Health Care System. All AD patients met the National Institute of Neurological and Communicative Diseases and Stroke – Alzheimer's Disease and Related Disorders Association (NINCDS/ADRDA) criteria for possible or probable Alzheimer's disease (Khachaturian, 1985; McKhann et al., 1984). The PD patients (aged 52 to 75 years) were screened and tested at the VA Palo Alto Health Care System as part of a neuropsychological protocol. All PD patients were evaluated by a physician, displayed at least two of the three cardinal features of the disease (i.e., tremor, rigidity, bradykinesia), and were taking antiparkinsonian medications with favorable response. The NC subjects were recruited by advertisements distributed throughout the community or by word-of-mouth and were paid for their participation; subsets of these subjects have been used in other studies from our laboratory (Fama et al., 1997; Pfefferbaum et al., 1994; Sullivan, Mathalon, Lim, Marsh, & Pfefferbaum, 1997). This sample of 51 NC subjects (ages 52 to 85 years) was selected to span the ages of the two patients groups.

Screening for all participants included a psychiatric interview and medical examination. Potential participants were excluded if they had any significant history of psychiatric or neurological disorder not related to their diagnosis (e.g., stroke, closed-head injury), past or present alcohol or drug abuse or dependence, or other serious medical condition. Informed consent was obtained from all participants. Demographic information for all subject groups is summarized in Table 1.

Neuropsychological Measures

Nonverbal fluency test

Nonverbal fluency was assessed with the Ruff

Table 1. Demographic Data.

	Controls (n = 51)		AD (n = 38)		PD (n = 20)		Group Comparisons[b]
	M	(*SD*)	*M*	(*SD*)	*M*	*SD*	
Age (years)	66.7	(7.4)	71.4	(6.8)	64.9	(6.6)	Control = PD < AD
Education (years)	16.4	(2.3)	15.0	(3.5)	16.0	(2.7)	NS
Duration of Diagnosis	–		4.8	(3.6)	7.3	(5.9)	PD > AD
Premorbid IQ Estimate[a]	115.6	(5.9)	106.1	(8.5)	112.9	(5.7)	Control = PD > AD
MMSE (max = 30)	28.8	(1.1)	18.4	(4.4)	27.4	(2.6)	Control > PD > AD

Note. AD = Alzheimer's disease; PD = Parkinson's disease.
Group comparisons: T test, $p < .05$.
[a] NART.
[b] T test, $p \leq .05$

Figural Fluency Test (RFFT; Ruff et al., 1987), which requires subjects to generate as many different designs as possible by using straight lines to connect predetermined arrays of five dots. The test consists of five trials, each with a 1-min time limit. The nonverbal fluency score is the total number of correct, unique designs across the five trials.

Verbal fluency tests

The *semantic* fluency test consisted of two 1-min trials: subjects first generated names of different animals and then of inanimate objects. The semantic fluency score was the mean number of correct unique responses given across the two trials. The *phonological* fluency test required subjects to generate words that began with the letter 'F', then 'A', and finally 'S' (excluding proper nouns or the same word with different endings, e.g., sail, sails, sailed) in three 1-min trials (Borkowski, Benton, & Spreen, 1967). The phonological fluency score was the total number of different, correct words produced across the three trials. In addition, the number of correct responses within each 15-s interval was scored for each condition of both verbal fluency tests.

Several other neuropsychological tests were administered, including the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975), a measure of dementia severity; National Adult Reading Test (NART; Nelson, 1982), an estimate of premorbid intelligence; fine finger movement (Cooper, Sagar, Jordan, Harvey, & Sullivan, 1991; Corkin, Growdon, & Sullivan, 1981), a measure of parkinsonian rigidity; and an ideomotor apraxia test, which included buccofacial apraxia and hand/arm movements to verbal commands (Goodglass & Kaplan, 1983).

Statistical Analysis

Group comparisons were based on one-way and repeated measures analyses of variance (ANOVA), with follow-up t tests. Pearson product-moment correlations examined relationships between test measures. Regression analysis was used to adjust the three fluency tests for the effects of normal aging. Analysis of covariance (ANCOVA) was used in confirmatory analyses to control for potentially confounding variables (viz., motor ability, dementia severity) between groups.

RESULTS

Normal Age Effects on Fluency Performance

In order to examine the effects of normal aging on fluency performance, the scores for each fluency measure were correlated with age in the NC group. Age showed significant negative correlations with semantic fluency ($r = -.40$, $p < .01$) and nonverbal fluency ($r = -.37$, $p < .01$) but not phonological fluency ($r = .07$, NS; Fig. 1). Because of the age-related performance decline observed in the NC group, we computed age-corrected Z scores for the AD and PD patients based on the scores of the NC subjects. Use of standardized Z scores also ensured that all three fluency measures were on a common scale, thus permitting direct comparison across tasks. All measures were expressed as Z scores with the mean of the controls $= 0 \pm$ SD at any given age. For each measure, lower scores reflect worse performance. All of the following analyses used age-corrected Z scores unless otherwise specified.

Descriptive statistics for the verbal and nonverbal fluency raw scores for all three groups are presented in Table 2. Performance of the NC group is consistent with previously reported normative data (Ruff et al., 1987; Spreen & Strauss, 1991).

Group Differences on Verbal and Nonverbal Fluency Measures

Group differences across the fluency tests were examined with a 3 Group (AD, PD, NC) × 3 Fluency test (nonverbal, semantic, phonological) repeated measures ANOVA. The effects of Group ($F(2,90) = 81.22$, $p < .0001$), Test ($F(2,180) = 9.78$, $p < .0001$) and their interaction ($F(4,180) = 4.18$, $p < .01$) were significant. (Fig. 2). Posthoc analyses indicated that the AD group scored significantly worse than the PD and NC groups on all three fluency measures (all analyses $p < .001$), while the PD group had significantly lower nonverbal and semantic fluency scores than the NC group ($p < .01$).

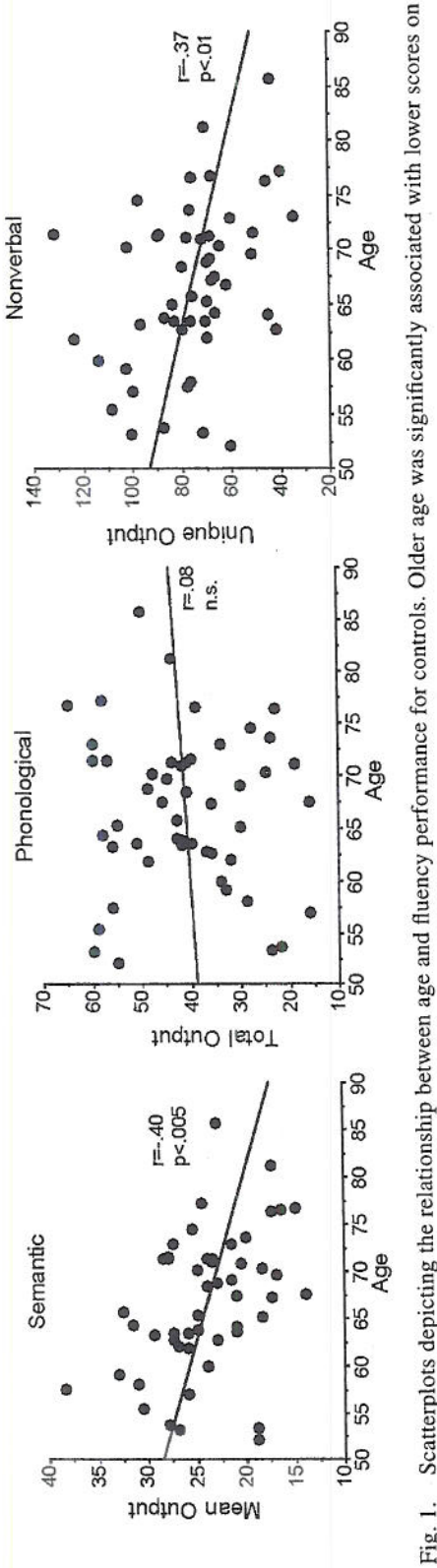

Fig. 1. Scatterplots depicting the relationship between age and fluency performance for controls. Older age was significantly associated with lower scores on semantic and nonverbal but not phonological fluency measures.

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Table 2. Raw Scores of Each Fluency Measure.

	M	(*SD*)	Minimum	Maximum
Nonverbal Fluency				
AD ($n = 25$)	27.2	(13.5)	8	52
PD ($n = 20$)	53.8	(24.5)	10	122
NC ($n = 50$)	76.1	(21.1)	35	132
Semantic Fluency				
AD ($n = 34$)	8.7	(4.7)	2	20.5
PD ($n = 19$)	20.2	(6.2)	8.5	30.5
NC ($n = 50$)	24.1	(5.1)	14	38.5
Phonological Fluency				
AD ($n = 38$)	20.7	(11.6)	2	50
PD ($n = 20$)	35.8	(12.5)	18	60
NC ($n = 50$)	41.3	(12.9)	16	65

Note. AD = Alzheimer's disease; PD = Parkinson's disease; NC = Normal controls.

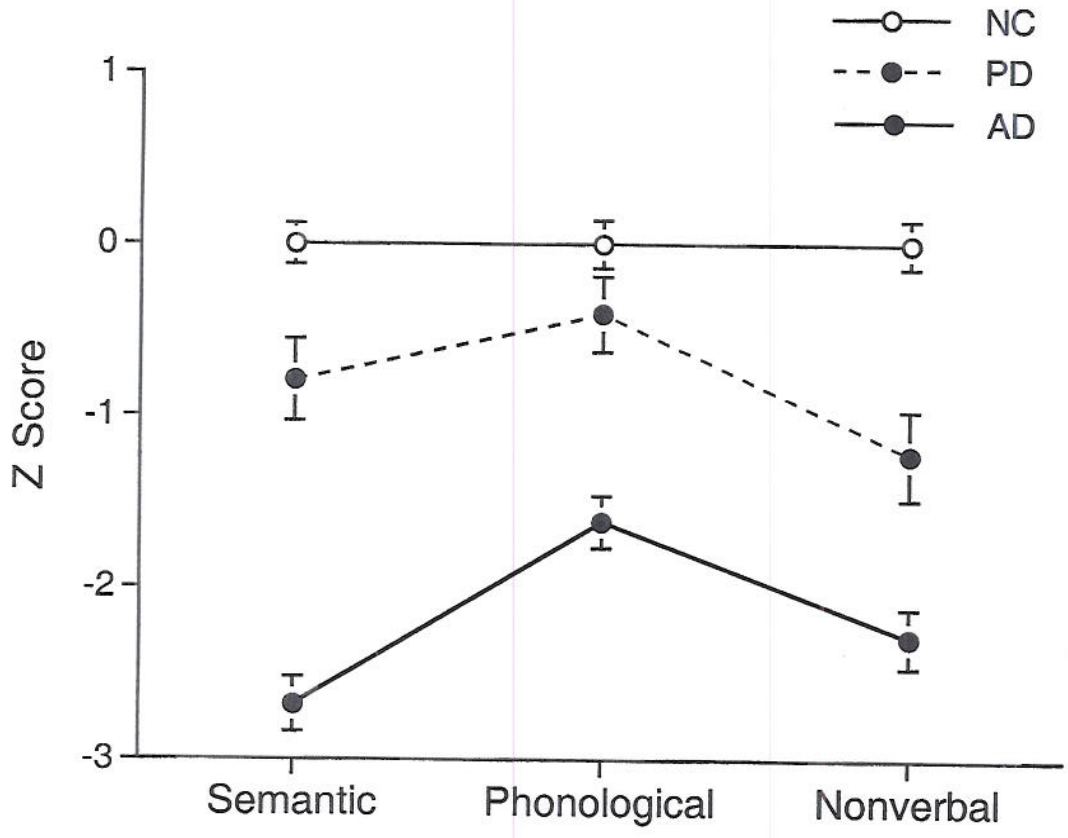

Fig. 2. The 3 Group (AD, PD, NC) × 3 Fluency (semantic, phonological, nonverbal) measure ANOVA. The AD group performance significantly worse than the NC and PD groups on all 3 fluency measures. The PD group performed significantly worse than the NC group on semantic and nonverbal fluency.

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Paired comparisons within the AD group revealed significantly lower scores on the nonverbal ($t(24) = 3.39$, $p < .01$) and semantic ($t(33) = 8.77$, $p < .0001$) fluency measures than the phonological fluency measure; semantic and nonverbal fluency test scores did not differ significantly from each other. Within the PD group, nonverbal fluency scores were significantly lower than phonological fluency scores ($t(19) = 3.23$, $p < .01$). The semantic fluency score was not significantly different from either the nonverbal or the phonological score.

Fluency Performance Across Time Epochs

Both semantic (animals, inanimate objects) and all phonological (F, A, S) trials showed a significant group effect, and all trials, with the exception of the S trial, showed a significant time epoch effect (Table 3 and Fig. 3). Each subject group generated significantly more words in the first 15-s interval than in later intervals (Scheffé F test: $p < .05$). The number of responses in the AD group leveled off earlier, usually approaching floor level by the second time epoch, than the NC and PD groups. This was reflected in a significant Group × Time interaction for the object, animal, F, and A trials.

Fluency Performance Controlling for Dementia Severity and Motor Deficits

To examine whether the group differences found between the AD and PD groups in fluency conditions were primarily due to differences in dementia severity between these groups an analysis of covariance with MMSE score as the covariate was conducted. These analyses indicated that the previously observed differences between the AD and PD groups on nonverbal and phonological fluency scores did not persist when level of dementia severity was controlled. However, even after taking MMSE scores into account, the AD group still showed a trend toward lower semantic fluency scores than the PD group ($F(2,49) = 3.2$, $p < .08$).

Next we examined whether scores on a test of finger rigidity could account for decreased fluency scores, particularly nonverbal fluency scores. Analyses controlling for fine finger

Table 3. Fluency Performance Across Time Epochs.

	df	*F*	*p*
Semantic fluency			
Objects			
Group	2, 98	53.89	.001
Time Epochs	3, 294	4.01	.008
Group × Time	6, 294	2.82	.011
Animals			
Group	2,98	89.38	.001
Time Epochs	3, 294	15.20	.001
Group × Time	6, 294	9.01	.001
Phonologic fluency			
F			
Group	2, 104	15.23	.001
Time Epochs	3, 312	10.47	.001
Group × Time	6, 312	6.69	.001
A			
Group	2, 105	31.69	.001
Time Epochs	3, 315	6.99	.001
Group × Time	6, 315	3.35	.003
S			
Group	2, 102	28.76	.001
Time Epochs	3, 306	0.13	.941
Group × Time	6, 306	0.73	.628

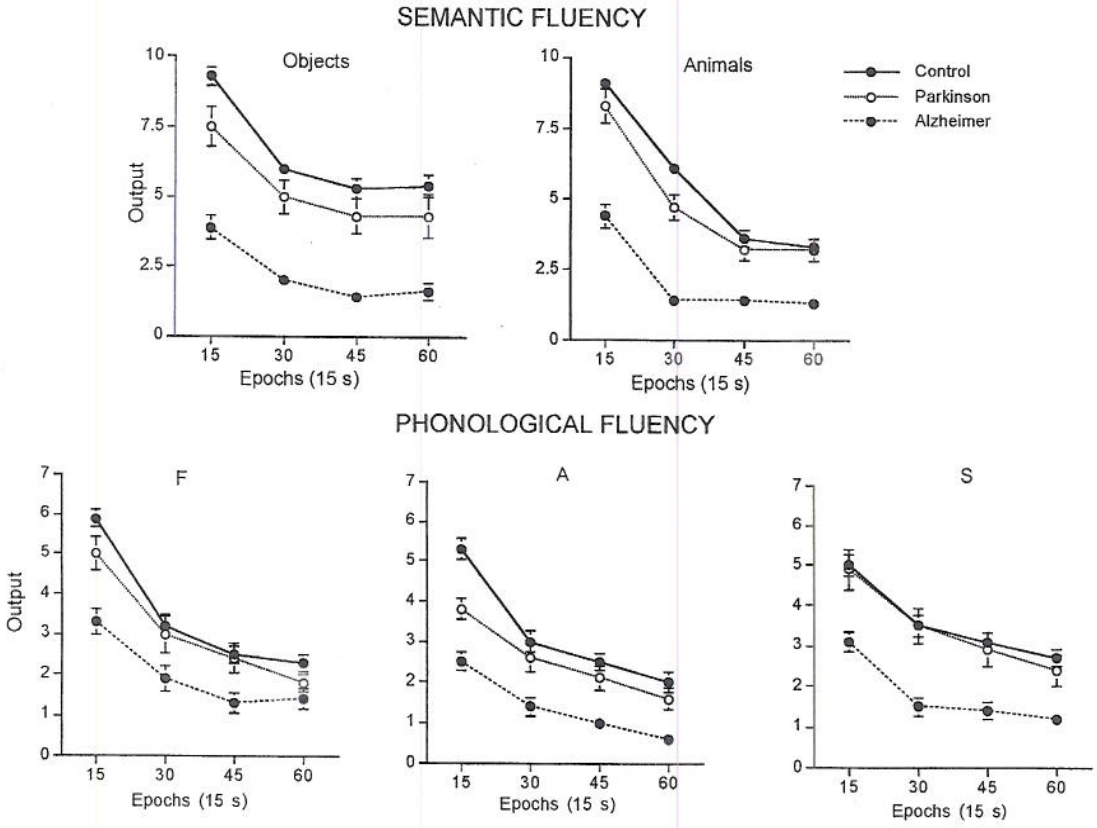

Fig. 3. All groups (NC, PD, AD) generated the greatest number of exemplars across the semantic and phonological fluency trials during the first 15-s interval of each trial. Performance dropped considerably for all subject groups for the remaining time intervals, with the AD subjects approaching floor effects on several trials.

movement indicated that all previously reported significant group differences between the patient groups and NC group persisted. In addition, scores on an apraxia test, could not account for the group differences noted between the patient groups and NC group. Thus, the observed group differences between the patient and control groups are not explainable on the basis of rigidity or apraxia.

Relationship Between Demographic Variables and Fluency Performance

Even after accounting for the effects of age, nonverbal fluency performance in the AD group still correlated with age ($r = .67$, $p < .0002$), whereby the younger AD subjects produced fewer unique designs than the older AD subjects when compared to age appropriate control subjects (Table 4). In the PD group, no age relationships were evident. Education was not significantly correlated with any of the three fluency scores for either the AD or PD groups. In the AD group, MMSE scores were significantly correlated with semantic ($r = .57$, $p = .0005$) and phonological ($r = .46$, $p < .005$) fluency scores, and a trend was found for nonverbal fluency scores ($r = .38$, $p < .07$), with lower MMSE scores associated with poorer fluency performance. In the PD group, MMSE scores were significantly correlated with nonverbal fluency scores ($r = .55$, $p < .02$) and a trend was noted with semantic fluency scores ($r = .45$, $p < .06$).

No significant relationship was found for MMSE scores and phonological fluency scores in the PD group ($r = .04$, $p = .85$). The NART IQ showed a significant correlation with the semantic ($r = .44$, $p < .02$) and phonological ($r = .48$, $p < .004$) fluency scores in the AD group and was modestly correlated with nonverbal fluency scores ($r = .45$, $p < .06$) in the PD group, with higher NART IQ scores tending to be associated with better fluency performance.

Intercorrelations among Fluency Measures

In the NC group, raw scores on nonverbal fluency were significantly correlated with raw scores on semantic fluency ($r = .28$, $p < .05$) but not raw scores on phonological fluency ($r = .01$, $p = .96$). Semantic fluency scores were not significantly correlated with phonological fluency scores in this sample ($r = .21$, $p = .15$).

Examination of age-corrected Z scores revealed that in the AD group, semantic fluency scores correlated significantly with nonverbal fluency ($r = .67$, $p = .0002$) and phonological ($r = .70$, $p < .0001$) scores; however, nonverbal fluency and phonological scores were not significantly related (Table 5). A different pattern of correlations was found in the PD group: nonverbal fluency scores significantly correlated with both phonological ($r = .53$, $p < .02$) and semantic ($r = .45$, $p < .05$) fluency scores, but phonological and semantic fluency scores were not significantly correlated.

DISCUSSION

Fluency Patterns in Healthy Control Subjects

Semantic and nonverbal fluencies, but not phonological fluency, showed significant decline with normal aging. These results are consistent with previous reports of declining semantic and figural, but not phonological, fluency in normal seniors (Bolla, Lindgren, Bonaccorsy, Bleecker, 1990; Crossley, D'Arcy, & Rawson, 1997; Ruff et al., 1987). Clearly, the effects of normal aging must be considered when investigating fluency performance in age-related diseases.

The number of exemplars generated in the NC group for each verbal fluency trial provided an index of the size of the semantic and phonological categories assessed. More exemplars were generated in the semantic than the phonological trials, suggesting a facilitated access to the lexicon through deeper (semantic) relative to shallower (phonological) levels of processing. A natural organization of words occurs with a hierarchical structure based on semantic modes (e.g., Collins & Quillian, 1969; Hodges, Graham, & Patterson, 1995). With age, either access to this semantic network or the network itself deteriorates, thus rendering semantic fluency tasks at greater risk than phonological fluency tasks, which require more superficial retrieval strategies. These age-related differences were evident in this study.

Consistent with previous studies that assessed fluency performance across time epochs (Crowe, 1997; Ober et al., 1986; Rosen, 1980), we found that the greatest number of correct

Table 4. Correlations Between Demographic Variables and Fluency Age-Corrected Z Scores.

	AD			PD		
	Nonverbal	Phonological	Semantic	Nonverbal	Phonological	Semantic
Age (years)	.67***	−.17	.25	−.06	−.33	−.13
Education (years)	.13	.18	.12	.37	.12	−.06
NART IQ	.20	.48**	.44*	.45	.02	.11
MMSE	.38	.46**	.57***	.55*	.05	.45

Note. AD = Alzheimer's disease; PD = Parkinson's disease.
* $p < .05$; ** $p < .01$; *** $p < .0001$.

Table 5. Intercorrelations Between Age-Corrected Z Scores of Fluency Measures.

	AD				PD		
	Nonverbal	Phonological	Semantic		Nonverbal	Phonological	Semantic
Nonverbal	–	.25	.67 ***	Nonverbal	–	.45 *	.53*
Phonological		–	.70 ***	Phonological		–	.38

Note. AD = Alzheimer's disease; PD = Parkinson's disease.
* $p < .05$; ** $p < .01$; *** $p < .0001$.

responses were given within the first 15-s time epoch for all semantic and phonological fluency trials. Word retrieval probably becomes more effortful as a fluency trial continues because fewer available words meet the rules of the fluency trial and generated words must be kept in working memory so as not to be repeated. These results are consistent with previous reports of a readily available working lexicon requiring less effortful processing for retrieval at the initiation of a fluency trial (cf. Crowe, 1997) and once this lexicon is depleted responses require a more active and effortful search.

Parkinson's Disease

The PD group was impaired in nonverbal and semantic, but not phonological, fluency compared to the NC group. These findings are consistent with previous reports of impaired semantic fluency in PD (Auriacombe et al., 1993; Beatty et al., 1989; Raskin et al., 1992; Tröster et al., 1989). Although we did not find the statistically significant phonological fluency deficit in our PD group reported by others (Gurd & Ward, 1989), PD performance on phonological fluency was almost a half standard deviation below the NC mean. In contrast to the total scores, the PD group did show a significant impairment at the earliest time epoch (i.e., first 15-s) for the letters F ($p = .032$) and A ($p = .002$) of phonological fluency, but not at the later epochs and not for the letter S (Fig. 3). Thus, the most sensitive measure of the PD phonological fluency deficit is early in the test, when the pool of possible exemplars is largest and when impairment in response initiation is likely to be most evident in PD patients. In the case of phonological fluency, total scores masked the detection of actual deficits, suggesting the importance of noting the progression of performance within trials as well as summary scores.

Alzheimer's Disease

Consistent with previous studies (Bigler et al., 1988; Butters et al., 1987; Mickanin et al., 1994), the AD group was impaired on all three fluency measures. These results suggest a generalized deficit in spontaneous generation of information in AD, regardless of whether assessed verbally or nonverbally. In addition, the AD group was more impaired on semantic and nonverbal than phonological fluency, suggesting an additional impairment for semantically related and visuospatially based information, over and above any generative disability in AD. This severe semantic fluency impairment is consistent with the hypothesized breakdown in semantic knowledge in AD (cf. Butters et al., 1987; Monsch et al., 1994; Rosser & Hodges, 1994). Although the AD group generated far fewer exemplars than the NC and PD groups, the performance pattern over time epochs generally followed the same pattern in all groups, with the greatest number of exemplars produced in the first 15-s epoch. However, unlike the NC and PD groups, who on several trials continued to produce more responses within the second time epoch (15-30 s within a trial) than during the last time epoch (45-60 s within a trial), the AD group essentially exhausted their store of responses within the first 15-s time epoch, showing no difference between the second and last time epoch.

Influence of Dementia Severity and Motor Factors on Fluency Performance

Consistent with previous reports [cf. (Barr & Brandt, 1996; Fischer et al., 1988)], dementia severity was generally related to fluency performance in the AD and PD groups. Nonverbal and semantic fluency performance of the PD patients with mild dementia resembled that of the AD group [cf. (Bayles et al., 1993)], although phonological fluency was not as strongly affected by dementia. When dementia severity was controlled, only semantic fluency was found to be modestly impaired in the AD compared to the PD group. Thus, in addition to a general fluency impairment which may be common to dementing illnesses, AD patients may show a selective semantically based fluency deficit (cf. Butters et al., 1987; Monsch et al., 1994; Rosser & Hodges, 1994).

Even after controlling for the possible effects of rigidity and apraxia on nonverbal fluency, the nonverbal fluency deficits observed in the AD and PD groups remained. Consequently, the nonverbal fluency impairments present in the AD and PD groups did not appear to be primarily related to fine motor disability or apraxia.

Interrelationships among Fluency Tests

Nonverbal fluency was more related to semantic than phonological fluency in the NC and AD groups and was associated with both phonological and semantic fluency in the PD group. Although the nonverbal fluency task used was not based on an explicit semantic category, the restrictions imposed (straight lines, presentation of a previously determined five-dot array) may make it more similar to the task demands inherent in the semantic versus phonological fluency task. Both the AD and PD groups showed significant impairment on this task compared to the NC group. Thus, contrary to our prediction, nonverbal fluency was not more reflective of phonological than semantic fluency. These results are, however, consistent with a recent study by Ruff, Light, Parker, and Levin (1997) who reported that although the RFFT was significantly correlated with a phonological fluency task, it did not account for a significant portion of the variance once the influence of other measures were taken into account (e.g., WAIS-R Digit Span). These findings provide little evidence to support the view that the figural fluency test (Ruff, 1988) can be simply viewed as a nonverbal analogue to phonological fluency.

Relevance to Clinical Assessment

These results highlight the importance of inclusion of a semantic fluency measure in the differential diagnosis of AD in relation to other dementing conditions. Even when dementia severity was controlled for, AD patients generally performed worse than PD patients on semantic but not phonological or nonverbal fluency. Further, notation of progress in the verbal fluency tests permitted process-oriented analyses (Kaplan, 1988) of output. When appropriate norms are established, this process approach may serve to reveal distinctive patterns of fluency impairments characteristic of different dementing diseases. Finally, the exclusion of a nonverbal fluency measure in the assessment of dementia related to motor diseases (e.g., PD) on the sole basis of symptoms of apraxia or rigidity is not warranted and that performance on such a task likely reflects underlying cognitive processes, at least in the early to moderate stages of the disease.

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