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Verbal Fluency in Bilingual Spanish/English Alzheimer's Disease Patients

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Studies have demonstrated that in verbal fluency tests, monolinguals with Alzheimer's disease (AD) show greater difficulties retrieving words based on semantic rather than phonemic rules. The present study aimed to determine whether this difficulty was reproduced in both languages of Spanish/English bilinguals with mild to moderate AD whose primary language was Spanish. Performance on semantic and phonemic verbal fluency of 11 bilingual AD patients was compared to the performance of 11 cognitively normal, elderly bilingual individuals matched for gender, age, level of education, and degree of bilingualism. Cognitively normal subjects retrieved significantly more items under the semantic condition compared to the phonemic, whereas the performance of AD patients was similar under both conditions, suggesting greater decline in semantic verbal fluency tests. This pattern was produced in both languages, implying a related semantic decline in both languages. Results from this study should be considered preliminary because of the small sample size.

Keywords: Alzheimer's disease; Spanish; verbal fluency; language; bilingualism; dementia

One of the earliest symptoms indicating a language decline in Alzheimer's Disease (AD) is word-retrieval difficulties.[1] Word retrieval is frequently tested by using verbal fluency tasks.[2,3] Two conditions can be used: phonemic (letter) and semantic (category). Phonemic verbal fluency requires the subject to retrieve words that begin with a particular phoneme or letter, whereas semantic verbal fluency requires the subject to name words that belong to a particular category (eg, animals). Fluency tests have proven useful in the diagnosis of dementia.[4,5] Most of these studies have included monolingual subjects, and no attention has been paid to the possible influence of bilingualism on word retrieval, despite the fact that recent findings suggest that lifelong experience of managing 2 languages can influence the individual's scores in cognitive test performance,[6-8] including verbal fluency.[9] This study analyzes the performance of bilingual AD patients on phonemic and semantic verbal fluency tasks and compares it with a bilingual, cognitively intact sample.

Studies with AD patients have shown that they perform poorer than normal controls under both phonemic and semantic cue conditions.[10,11] However, numerous studies have demonstrated that AD patients show greater difficulties retrieving words under the semantic condition than the phonemic condition.[12,13] Semantic verbal fluency tasks are also better at discriminating AD patients from normal elderly individuals compared to phonemic fluency tasks.[5] In a longitudinal study that assessed the verbal fluency of AD patients over a 3-year period, AD patients demonstrated impairment compared to control subjects under both semantic and phonemic conditions,

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although the rate of decline over the years was faster for the semantic condition.[14]

The pattern of performance of AD patients on verbal fluency tasks is contrary to what has been found in normal participants, who tend to perform better under the semantic condition. Healthy, normal adults usually produce about 16 words under semantic (animal category) conditions and about 12 words under phonemic conditions.[3,15,16] Age may be an important variable in performance of fluency tasks, as in cognitively normal adults, where increasing age seems to affect performance in category fluency to a higher degree than letter fluency.[17]

Retrieval of words may be facilitated in normal individuals under the semantic condition by the use of semantic clusters among related items. Meanwhile, retrieval under the phonemic condition may be more difficult because semantic clusters must be inhibited.[3] It has been hypothesized that the difficulties of AD patients in semantic verbal fluency tasks are caused by deficits in semantic memory.[13,18] Semantic memory appears to be impaired even in the early stages of the disease,[19-21] although it is unknown whether these semantic memory deficits are manifest in both languages in bilingual AD patients.

The relatively few studies that have examined the impact of bilingualism on verbal fluency have shown that on semantic verbal fluency tasks, balanced bilinguals tend to perform similarly in both languages.[22,23] However, a dissociation between semantic and letter fluency between bilinguals and monolinguals has also been reported. Older Spanish/English bilinguals perform worse than monolinguals on semantic fluency, but not on letter fluency, in both the preferred and nonpreferred language.[9] Similarly, using a younger sample of Spanish/English bilinguals, Gollan, Montoya, and Werner found that although the bilinguals' performance tended to be poorer on both semantic and phonemic fluency, the difference in performance was larger in the semantic fluency condition.[24]

The effect of bilingualism on the cognitive decline in AD patients is not well understood. Little has been published on the linguistic abilities of bilingual AD patients. The few reports that have addressed the impact of bilingualism on language function in AD patients have been case studies in which a discourse or conversational approach has been employed.[25,26] These studies have found that language impairment among bilingual and monolingual patients is similar, but that each of the languages is affected differently. Findings suggest that patients have difficulties inhibiting their native language (L1) when speaking in their secondly acquired language (L2), perhaps because many aspects of language that are automatic in L1 require controlled processing in L2.[26] Controlled processing of language functions is impaired in AD patients, resulting in especially great difficulty when the patient uses L2. Nevertheless, it is not known what role bilingual variables play in the language decline of bilingual AD patients.

DePicciotto and Friedland compared semantic verbal fluency in 6 highly proficient English/Afrikaans bilingual AD patients with that of cognitively normal elderly bilinguals.[22] As expected, the performance of the AD patients was poorer than that of the normal bilinguals. The investigators did not find a significant difference in performance between languages, but for the AD patients, there was a trend for scores to be higher in L1 than L2. The study also indicated that age of acquisition of L2 and percentage of usage (L1 versus L2) played a role in the performance of verbal fluency, but the nature of this role was not clear. Interestingly, a relationship between fluency performance and age of L2 acquisition or pattern of language use was not found in the cognitively normal bilinguals. Levels of language proficiency were not examined.

The present study aimed to determine whether the pattern of greater difficulties retrieving words under the semantic rather than the phonemic condition is reproduced in the 2 languages of Spanish/English bilingual AD patients. The number and type of errors produced under the semantic and phonemic conditions were analyzed, as well. The use of semantic clusters when performing the semantic verbal fluency task by cognitively normal and AD subjects was compared.

A significant interaction was predicted between the type of verbal fluency task and group (AD patient vs. cognitively normal elderly): the AD patients would demonstrate more difficulties under the semantic condition compared to cognitively normal individuals. This prediction was based on the finding that semantic difficulties tend to occur in the early stages, whereas phonological difficulties tend to occur later in AD patients.[13,27] It was also hypothesized that these difficulties would be evident in both languages in bilingual AD, albeit to a greater extent in L2, because impairment in semantic memory and lexical selection would result in disproportionate difficulty when AD subjects are tested in L2.[26] If the preceding

Table 1. Demographic Characteristics of Alzheimer's Disease (AD) Patient Group (n = 11) and the Control Group (n=11)

	AD Patients			Controls		
Characteristic	Mean	SD	Range	Mean	SD	Range
Age	76.82	6.94	69-91	76.27	7.34	68.92
Years of education	12.82	5.04	4-19	12.45	4.44	2-17
MMSE	21.18	3.31	16-24	27.82	1.94	24-30
Age of L2 acquisition	20.27	15.20	3-50	21.45	15.71	3-45

SD indicates standard deviation; MMSE, Mini Mental State Evaluation; L2, second language.

hypotheses are correct, we expect a 3- way interaction between language (L1/L2), category type (semantic/letter), and cognitive status (control/AD). For these interactions to be borne out, we assume that semantic fluency generates more between-language competition than letter fluency, that fluency performance in L2 requires controlling activation of L1,[24] and that AD affects semantic memory.[12]

Methods

Participants

We selected 11 Spanish/English bilingual subjects with mild to moderate severity probable AD (3 males, 8 females; mean age 76.82; mean Mini-Mental State Examination [MMSE][28] = 21.2), from among 35 Hispanic patients who consulted for memory problems at the Wien Center for Alzheimer's Disease and Memory Disorders at Mount Sinai Medical Center in Miami Beach, Florida. Subjects were excluded if they did not meet criteria for bilingualism (n = 19) (see criteria for bilingualism below) or if they did not meet criteria for probable AD (n = 5). All of the patients were diagnosed with probable AD by an experienced neurologist (RD) using NINCDS-ADRDA criteria.[29] They presented with memory impairment, as well as deficits in language, executive functions, and/or visuospatial abilities. Neuroimaging and blood tests were used to rule out other treatable or reversible illnesses.

The control subjects (n = 11) were healthy, elderly, Spanish/English bilinguals (3 males, 8 females; mean age 76.27), selected from a South Florida community sample of 170 Hispanic volunteers, recruited from senior recreation centers, who participated in a separate study. Of these volunteers, 135 reported that they were Spanish monolinguals, and 35 reported that they were Spanish/English bilinguals. Participants who indicated they were bilinguals were contacted and interviewed. Those who matched a participant from the AD group by gender, age, educational level, and degree of bilingualism were selected. Only control participants with MMSE scores of 25 or higher and who lived independently were chosen. Among matched pairs of subjects, a 1-year difference in age or a 1-year difference in education was permitted.

Spanish was the primary language of the participants for both groups. Fourteen of the participants were born in Cuba, 4 in Puerto Rico, and 4 in other Latin American countries. General characteristics of the participants are described in Table 1; no difference between the cognitively normal participants and the AD patients was found in age of L2 acquisition, $F(1, 20) = 0.032$, $P = .86$, or in their self-report of language proficiency report, $F(1, 20) = 0.000$, $P = 1.000$. As expected, MMSE scores of the AD patients were lower than those of their cognitively normal peers ($F[1, 20] = 32.895$, $P < .001$).

Assessment of Bilingualism

To determine language history and degree of bilingualism, all participants completed a questionnaire assessing language proficiency. The questionnaire included a 5-point self-rating scale. Participants were asked to rate themselves on how well they understood and spoke Spanish and English using the following scale: 1 (not at all), 2 (limited), 3 (relatively well), 4 (quite well), and 5 (excellent). This questionnaire (see Appendix) has been used in a previous study with a Hispanic sample in south Florida.[30] Table 2 shows the means and standard deviations (SD) for each questionnaire's question per group. Significant correlations between self-rating questionnaires of language proficiency and actual language proficiency have been previously reported.[31] The information provided by the

Table 2. Comparison between Controls and Alzheimer's Disease (AD) Patients on Variables Influencing Bilingualism

Variable	Alzheimer's Disease Patients			Controls				
	Mean	SD	Range	Mean	SD	Range	*t*	*P*
Age of L2 acquisition	20.27	15.20	47	21.45	15.40	42	-0.179	.860
Understand L2	4.00	0.78	2	4.00	0.63	2	0.000	1.000
Speak L2	3.64	0.81	2	3.73	0.65	2	–0.291	.774
Understand L1	5.00	0.00	0	5.00	0.00	0	*	*
Speak L1	4.82	0.41	1	4.73	0.47	1	0.488	.631
% of L2 use (in the past 10 years	1.91	0.95	2	2.27	1.10	3	–0.830	.416
% of L1 use (in the past 10 years)	4.36	0.92	2	4.09	1.17	3	0.649	.524
% of L2 use (while growing up)	1.18	0.60	2	1.09	0.30	1	0.447	.660
% of L1 use in the home (while growing up)	4.55	1.04	3	4.91	0.30	1	–1.118	.227
% of L2 use in school (while growing up)	1.45	1.21	4	1.64	1.29	4	–0.341	.737
% of L1 use in school (while growing up)	4.09	1.22	3	4.55	0.82	2	–1.025	.318
% of L2 use in the community (while growing up)	1.18	0.60	2	1.55	1.21	3	–0.890	.384
% of L1 use in the community (while growing up)	4.45	1.04	3	4.64	0.92	3	–0.434	.669
% of L2 use in general (while growing up)	1.18	0.60	2	1.64	1.21	3	–1.118	.227
% of L1 use in general (while growing up)	4.55	1.04	3	4.55	0.93	3	0.000	1.000

Note: For the questions in the appendix asking for the percentage of language use: 1 corresponds to 0%–20%; 2 corresponds to 21%–40%; 3 corresponds to 41%–60%; 4 corresponds to 61%–80%; 5 corresponds to 81%–100%.
L1 indicates native language; L2, second language; SD, standard deviation.
***t* test cannot be completed because the standard deviations of both groups are 0.

AD patients was corroborated by the caregivers by asking them to review the answers given by the patients, and no discrepancies were observed. Participants who rated their ability to speak and understand both Spanish and English as "relatively well," "quite well," or "excellent" were selected. As explained above, the control sample was selected to match the AD sample in different variables, including the degree of bilingualism. Therefore, each pair of participants had the exact same score in the self-described questionnaire of language proficiency. The mean rating of all participants for understanding (M = 5.00; SD = 0.000) and speaking (M = 4.77; SD = 0.429) Spanish (L1) was higher than the mean rate for understanding (M = 4.00; SD = 0.690) and speaking (M = 3.68; SD = 0.716) English (L2), which indicates that they were more proficient in Spanish.

Eight participants reported that in the past 10 years, they had used English at least half of the time. Six participants reported using English 20% to 40% of the time. Seventeen of the participants stated that they preferred speaking in Spanish, and 5 indicated that they did not have a preference for either Spanish or English. Fifteen of the participants had learned English through formal education, such as in elementary school or in English classes. Seven had learned English informally in the community.

Measures and Procedures

Fluency tests. The following language functions were tested:

1. Verbal fluency within a phonemic category. Three 1-minute fluency trials were given using the letters F, A, and S.[32,16] Participants were instructed not to produce proper names. One point was given for each correct exemple produced. Words starting with the same sound but a different letter were not considered correct (eg, allophones such as "hacer" for the letter "A"). Numbers were accepted. The score consisted of the average of points given under each of the letters F, A, and S.

2. Verbal fluency within a semantic category. A 1-minute fluency trial, using "Animals" as the category, was given.[32,16] Credit was given for superordinate categories (eg, birds). Once the superordinate was accepted, specific exemples in that category were also accepted. For example, if the participant said "birds" and "eagle," both were accepted as correct. Gender distinctions (eg, cow, bull) and age distinctions (eg, cow, calf) were also accepted. The score was the total points given under the category "Animals."

Interrater reliability of $r = 0.98$ has been reported for verbal fluency tests.[33] Test-retest reliability with retesting occurring 6 months later has produced a reliability coefficient of $r = 0.74$.[34] Retesting of a group of elderly individuals after 1 year yielded a reliability coefficient of $r = 0.71$.[35] In addition, semantic verbal fluency has been shown to have 68% sensitivity and 83% specificity to differentiate AD patients from normal controls.[36]

The verbal fluency tests were administered in both Spanish and English. To control practice effects, the order of language of administration was counterbalanced across subjects. All subjects were administered the phonemic fluency test first, followed by the semantic fluency test. Thus, half of the subjects received the phonemic fluency test in Spanish followed by the category test in Spanish and then completed the corresponding tests, in order, in English. The other half performed the phonemic fluency test in English followed by the category test in English and then completed the corresponding tests, in order, in Spanish.

The number of errors within each verbal fluency condition was calculated. Two types of errors were identified: intrusions and perseverations. For the phonemic fluency test, intrusions consisted of words that were proper names, that began with a different phoneme, or that were retrieved in the nontarget language. For the semantic fluency test, intrusions consisted of words belonging to a different semantic category or words produced in the wrong language. Perseverations consisted of repetition of a correct word already produced within the trial for each language. However, if a subject said "caballo" and "horse" in Spanish and English, respectively, it was counted as correct in the trial of the corresponding language.

The 17 subcategories presented in Roberts and Le Dorze were used to classify the animals named under the semantic condition.[23] Roberts and Le Dorze selected these subcategories based on the responses of 40 subjects. In order to determine which animals belong in each of the subcategories, Roberts and Le Dorze developed a questionnaire in which they asked respondents to indicate in which subcategory a list of animals belonged. In the present study, no animals were produced under 6 of 17 subcategories. The remaining 11 subcategories represented in the present study were birds, farm, fish, forest, insects, pets, prehistoric, reptiles, rodents, water, and wild. The number of semantic clusters produced under the semantic verbal fluency task was also calculated. A semantic cluster was defined as 2 or more consecutive words belonging to a particular subcategory (eg, insects). A subcategory is a subdivision that has general distinguishing characteristics within a larger category. For example, "birds" and "insects" are subcategories of the larger category of "animals."

Statistical Analysis

Verbal fluency performance between the cognitively normal and the AD participants was analyzed using a $2 \times 2 \times 2$ repeated-measures analysis of variance (ANOVA) mixed design. The within-subjects factors were language (Spanish vs. English) and cue condition (phonemic vs. semantic). The between-subject factor was group (controls vs. AD patients). The effect sizes were assessed using partial *eta*² ($p\eta^2$) for overall group differences. Type I error probability was set to 0.05.

The average percentage of perseverations and intrusions in each language in the normal versus the AD group was calculated, and each type of error (intrusion or perseveration) was analyzed in each group using a $2 \times 2 \times 2 \times 2$ repeated-measures ANOVA within-subject design. The within-subject factors were language (Spanish vs. English), cue condition (phonemic vs. semantic), and type of error (intrusion vs. perseveration). The between-subject factor was cognitive group (cognitively normal vs. AD). For the semantic condition only, 1-way analyses of variance were conducted to compare the number of subcategories and the number of semantic clusters produced by each group (AD patient vs. controls) in each language. In order to verify the reliability of the scoring errors (intrusions and perseverations) and of the semantic cluster grouping, a second rater was used to check for interrater reliability. Reliability coefficients for intrusions, perseverations and semantic cluster grouping were 0.96, 1.0, and 0.95, respectively.

Table 3. Comparison of the Mean Number of Words Produced and Standard Deviation in Each Language and under Each Condition of 2 Groups of Spanish/English Bilingual Participants

	Controls		Alzheimer's Disease Patients		Total				
	Mean	SD	Mean	SD	Mean	SD	F	*P*	pη²
Phonemic									
Spanish	10.73	3.23	7.94	4.50	9.33	4.08	2.79	.11	0.12
English	7.24	2.88	4.42	3.56	5.83	3.47	4.16	.06	0.17
Semantic									
Spanish	15.55	6.09	8.09	3.56	11.82	6.19	12.28	.002	0.38
English	11.18	3.82	5.09	2.55	8.14	4.44	19.38	< .001	0.49

SD indicates standard deviation.

Results

Comparisons between the normal and the AD group showed that the main effect of language was significant for both semantic and phonemic conditions (F [1, 20] = 24.693, *P* < .001, $p\eta^2$ =0.55). More words were produced in Spanish (10.58) than in English (6.99). The main effect of the type of fluency task was significant, as well (F [1, 20] = 13.451, *P* = .002, $p\eta^2$ =0.40). More words were produced under the semantic condition (9.98) than under the phonemic condition (7.58). The main group effect was also significant (F [1, 20] = 14.153, *P* < .001, $p\eta^2$ = 0.41), with the control group producing more words than the AD group (44.70 and 25.54, respectively).

The interaction between group and verbal fluency task (ie, semantic or phonologic condition) was significant (F [1, 20] = 9.245, *P* = .006, $p\eta^2$ = 0.32). There was no difference between the 2 groups when performing the phonemic verbal fluency task in either Spanish or English. However, the cognitively normal participants performed the semantic verbal fluency task significantly better than the AD patients, regardless of whether they were using Spanish or English. The mean number of words produced in Spanish and in English under all task conditions for the 2 groups of participants are shown in Table 3.

The interaction between language and verbal fluency task condition was not significant (F [1, 20] = 0.038, *P* = .847, $p\eta^2$ = 0.002). More words were produced in Spanish than in English for both fluency tasks. No interaction was found between language, type of fluency task, and group (F [1, 20] = 0. 564, *P* = .461, $p\eta^2$= 0.03).

One-way ANOVAs were conducted to compare mean differences between semantic and letter fluency for the control and AD group. Significant differences were observed between the control group (mean difference = 4.82, SD = 5.53) and the AD group (mean difference = 0.15; SD = 3.06) in Spanish (F [1, 20] = 5.996, *P* = .024). In English, the same comparisons between the control (mean difference = 3.94, SD = 3.28) and the AD (mean difference = 0.67; SD = 2.39) groups also yielded significant differences (F [1, 20] = 7.147, *P* = .015). The AD group showed a smaller difference between the 2 fluency tests.

Significant differences were obtained in the number of semantic clusters produced in the semantic category task by each group when performing in Spanish versus English. Cognitively normal participants produced more semantic clusters, regardless of language of administration of the task (Table 4). As compared to the AD subjects, cognitively normal subjects also produced a significantly greater number of subcategories in English. Both AD and normal subjects produced more semantic clusters in Spanish compared to English (F [1, 20] = 5.352, *P* = .026, $p\eta^2$ = 0.11).

Table 5 shows the mean total number of errors and the percentages (number of errors divided by the total number of words produced per category) on each fluency task in English and in Spanish per group. The mean proportion of intrusions produced under the phonemic condition in English was 17% higher in AD patients than in cognitively normal subjects. The mean proportion of perseverations under the semantic condition was 10% higher in the AD patients than in cognitively normal individuals

Table 4. Comparison of Total Average Number of Subcategories and of Semantic Clusters Used in the Semantic Fluency Tasks for Each Language and under Each Condition of the 2 Groups of Spanish/English Bilingual Participants

	Controls		Alzheimer's Disease Patients				
	Mean	SD	Mean	SD	F	*P*	pη²
Spanish							
Subcategories	5.73	1.55	4.36	1.36	4.79	.041	0.19
Semantic clusters	7.09	3.62	2.55	1.57	14.60	.001	0.42
English							
Subcategories	5.45	1.51	3.36	1.63	9.76	.005	0.33
Semantic clusters	4.09	1.97	1.45	1.21	14.25	.001	0.42

Table 5. Comparison of the Total and Average Percentage of Perseverations and Intrusions in Each Language and under Each Type of Verbal Fluency Task of the 2 Groups of Spanish/English Bilingual Participants

	Controls				Alzheimer's Disease Patients			
	Perseverations		Intrusions		Perseverations		Intrusions	
	Total	%	Total	%	Total	%	Total	%
Phonemic								
Spanish	2.18	6	1.55	4	3.36	13	2.64	10
English	1.00	3	2.55	11	1.27	6	4.18	28
Semantic								
Spanish	1.09	7	0.09	0.4	1.45	14	0.09	1
English	0.18	2	0.00	0	1.00	12	0.00	0

when tested in English. A significantly greater total percentage of errors was produced in the phonemic condition than in the semantic condition (F [1, 20] =13.208, $P = .002$), and the AD group had a higher number of errors when compared to the control group (F [1,20] = 20.798, $P < .001$). A significant interaction between type of error (perseveration vs. intrusions), verbal fluency task (phonemic vs. semantic), and group (AD vs. controls) was found (F [1, 20] = 5.398, $P = .031$. The AD group made more perseverations in the semantic condition, whereas more intrusions were seen in the phonemic condition. None of the groups presented intrusions in the English semantic category test, and few intrusions were observed in Spanish.

Discussion

The results from this study support the hypothesis that bilingual AD patients are characterized by a greater decline in performance in semantic fluency tests when compared to phonemic fluency tests. A greater discrepancy in the performance between the cognitively normal subjects and the AD patients is observed under the semantic task compared to the phonemic task, regardless of the language of administration, suggesting a greater decline in semantic verbal fluency compared to phonemic verbal fluency. Furthermore, the number of words produced under the semantic condition by the AD patients was significantly lower than the number of words produced by the cognitively normal subjects apart from the language of administration, but there was not a significant difference in the number of words produced by the 2 groups under the phonemic conditions in both languages. This finding indicates that AD patients had more difficulty with the semantic task compared to the phonemic task, as has been previously reported.[12,13]

Contrary to our predictions, there was a lack of interaction between language, verbal fluency, and group. Patients with AD did not have more difficulty in retrieving words under the semantic condition in L2 as compared to L1. This lack of interaction suggests that control processing of L1 is not especially important for retrieving semantic category exemplars in L2, that is, even AD patients with deficits in cognitive control do not show particular difficulty with semantic fluency in L2 since their knowledge of both languages is relatively strong. This possibility is consistent with the findings by Rosselli et al,[9] who did not find cross-language differences in bilinguals when producing words in semantic and phonemic fluency tasks. In addition, the lack of interactions may have general implications about the verbal fluency task. That is, the task may tap retrieval and may reflect the nature of retrieval from categories much more than it taps controlled processing, as suggested by Gollan, Montoya, and Werner.[24]

Although the AD participants produced fewer words in L2 under all conditions, the pattern of performance and the type of errors in the 2 verbal fluency tasks in L2 and L1 and in both groups was similar, indicating a similar pattern of decline in the 2 languages. The most common type of intrusion under the phonemic condition for both the AD patients and the control subjects, in both Spanish and English, was proper names. For the AD patients, the second most common type of intrusion consisted of words that began with the wrong letter. This was also the case for the healthy controls, but only in English. However, intrusions beginning with the wrong letter produced by the controls seemed different than those produced by the AD patients. For example, under the letter A, when tested in English, controls produced words such as "out," "unusual," and "ostrich," which might sound as if they begin with the letter A to a less proficient bilingual English speaker. Patients with AD, on the other hand, produced words like "live," "go," and "emergency" under the letter A. In addition, for the controls, this type of error may be attributed to the fact that when performing in English, some of the individuals appeared to be thinking of correct words in Spanish and then translating them into English. For example, under the letter A, the word "love" was produced, which in Spanish begins with the letter A (ie, "amor"). The rest of the intrusions for both groups consisted of orthographic errors, such as saying words that began with the letter C for the S condition or PH for the F condition, saying nonwords, and saying words in the wrong language. Interestingly, for the AD group, saying words in the wrong language occurred only when performing in English. But for the control group, this type of error was more common when performing in Spanish than in English. When performing under the semantic condition, the only type of intrusion produced was words in the wrong language. Some of the errors presented by our sample could be explained by the inability that bilinguals have to turn one language off when producing words in another language.[24] Previous research has shown that bilinguals activate both languages during a task that requires a specific language,[37] and the other language is inhibited.[38,39] Our results suggest that during a phonemic task, controls have more difficulty inhibiting L2 during activation of L1, whereas in the same task, the AD patients show more difficulty inhibiting L1 during the activation of L2. Meuter and Alport argued that the magnitude of inhibition of L1 and L2 differs, and it is larger in L1 because it is more likely to be automatically available.[40] However, according to these authors, the degree to which L2 needs to be inhibited correlates with the degree of L2 proficiency. Therefore, when speaking in L1, normal proficient bilinguals show strong inhibition of L2 when compared to nonproficient bilinguals. Our results suggest a change in the inhibitory pattern of L2 in cases of AD, but further research is needed.

To our knowledge, the present study represents the first attempt to characterize performance in fluency tasks in Spanish/English bilingual older adults who are either cognitively normal or who have AD. DePicciotto and Friedland had previously examined verbal fluency in elderly bilingual (English/Afrikaans) patients with AD.[22] These authors analyzed the performance of 6 AD patients in semantic verbal fluency using the category "Animals." The mean number of words produced in their study was 3.5 (SD = 2.1) when performing the task in L1 and 2.5 (SD = 1.6) when performing the task in L2. The mean retrieval scores in their study were much lower than the means in the present study. This finding may be related to differences in disease severity in the 2 studies. The AD patients in the DePicciotto and Friedland study were classified as moderately demented, using the Clinical Dementia Rating (CDR) scale, whereas the patients in our study were in the mild to moderate stages of the disease, as indicated by their MMSE scores.

Demographic variables such as age and level of education were similar for the subjects in our study and DePicciotto and Friedman's study and do not seem to explain the differences in results. Further, linguistic differences between Afrikaans and Spanish do not appear to account for the differences, as evidenced by the mean number of animals produced in the Afrikaans language by their normal sample (14.9), which is similar to the number produced by our normal sample in Spanish. However, certain methodological differences between the 2 studies, such as the use of priming to guarantee that the participants were in the bilingual mode before performing the animal fluency task in the DePicciotto and Friedland study, could have resulted in a reduction in the number of words generated by their AD sample.

The present study also showed that the AD patients produced more exemplars when the tasks were performed in L1 than in L2. Our results are different from the study of DePicciotto and Friedland,[22] in which no significant difference in performance was found among bilinguals in the 2 languages in which they were proficient. This difference in the study findings is probably explained by a lower level of language proficiency in L2 for the subjects in our study as compared to those in the DePicciotto and Friedland study. This explanation is suggested by a rating of 4 or 5 on the 5-point self-rating language proficiency scale for L2 among their subjects, and a 3 to 5 rating in L2 among our subjects on the same scale. Other differences were a lower mean age (7 years) at L2 acquisition in the DePicciotto and Friedland study as compared to 20.27 years in our study. This difference indicates that formal schooling in L2 was likely among the subjects in DePicciotto and Friedland's study but not among our subjects, the majority of whom were raised in Latin America, where formal English education is uncommon.

In summary, the results from this study suggest that bilingual AD patients experience difficulties on semantic verbal fluency tasks. The difficulties are observed regardless of the language used to perform the task. Surprisingly, the difficulties were not intensified when the task was performed in L2. This finding implies that once a diagnosis of AD has been established in a Spanish/English individual, tests of verbal fluency can be applied in either Spanish or English to follow the decline of the verbal fluency skills of the patient as the disease progresses. Nevertheless, further studies are needed to determine whether the differences observed between the AD patients and the cognitively normal subjects are also seen when different semantic categories or a greater number of categories are used.

This study was based on a small sample, which limits the generalization of the results. However, to the best of our knowledge, the present study is the first of its kind, and the results, although preliminary, suggest that interesting hypotheses could be explored if the sample size were larger. Future studies could also examine the impact of bilingualism in other conditions that affect performance on phonemic or semantic verbal fluency tasks in order to determine the generalizability of the present findings. The results in this study are based on only one semantic category that was tested (animals). However, several semantic categories should be tested, because it has not always been found that normal people score higher on semantic categories.[4] Another shortcoming of our study is that the index of language proficiency was based on self-report, which is only a rough assessment, and more specific measures of language proficiency could have delivered stronger results. Nevertheless, self-report has been determined to be a reliable measure of language proficiency.[31]

A final point to be made is that our sample included late bilinguals. The impact of other types of bilingualism, such as early bilinguals and balanced bilinguals on verbal fluency task performance, should be investigated. Factors that are important in studies of bilinguals, such as age of second language acquisition and pattern of language use, could be investigated, in order to determine the most important factors in the performance of verbal fluency tasks. Further studies are needed to evaluate changes in language function among bilingual individuals with different dementia syndromes, given increasing globalization and greater demand for neuropsychological testing of bilinguals in the United States and elsewhere.

APPENDIX

BILINGUAL QUESTIONNAIRE

What is your preferred language? ___________________________
At what age did you acquire your second language?_____________
Methods used in the acquisition of English
___high school ___university ___family members
___English classes ___other (specify :_______________________)
In the last 10 years, what percentage of the time did you use Spanish:
___0-20% ___21-40% ___41-60% ___61-80% ___81-100%
In the last 10 years, what percentage of the time did you use English:
___0-20% ___21-40% ___41-60% ___61-80% ___81-100%
While growing up, what percentage of the time did you use English in the following situations?

	0-20%	21-40%	41-60%	61-80%	81-100%
(a) Home					
(b) School/ Work					
(c) Community					
(d) In general					

While growing up, what percentage of the time did you use Spanish in the following situations?

	0-20%	21-40%	41-60%	61-80%	81-100%
(a) Home					
(b) School/ Work					
(c) Community					
(d) In general					

a) Degree of fluency. Circle those that apply.
Spanish
Understand
1.Virtually nothing
2. Limited
3. Relatively well
4. Quite well
5. Excellent
Speak
1.Virtually nothing
2. Limited
3. Relatively well
4. Quite well
5. Excellent
b) Circle those that apply.
English
Understand
1.Virtually nothing
2. Limited
3. Relatively well
4. Quite well
5. Excellent
Speak
1. Virtually nothing
2. Limited
3. Relatively well
4. Quite well
5. Excellent

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