### Title

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# The Spanish-English bilingual experience and cognitive change in Hispanics/Latinos from the Hispanic Community Health Study/ Study of Latinos-Investigation of Neurocognitive Aging

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## Abstract

**INTRODUCTION:** Studies suggest bilingualism may delay behavioral manifestations of adverse cognitive aging including Alzheimer's dementia.

**METHODS:** 3,963 participants (unweighted mean population age~56y) at Hispanic Community Health Study/Study of Latinos baseline (2008–2011) self-reported their and their parents' birth outside the US, Spanish as their first language, and used Spanish for baseline and comparable cognitive testing 7-years later (2015–2018). Spanish/English language proficiency and patterns of use were self-rated from 1=only Spanish to 4=English>Spanish. Cognitive testing included

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CONFLICTS OF INTEREST
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test-specific and global composite score(s) of verbal learning, memory, Word Fluency, and Digit Symbol Substitution (DSS). Survey linear regression models examined associations between baseline bilingualism scores and cognition.

**RESULTS:** Higher second-language (English) proficiency and use were associated with higher global cognition, Fluency and DSS at follow-up and better than predicted change in Fluency.

**DISCUSSION:** The bilingual experience was more consistently related to 7-year level versus change in cognition for Hispanics/Latinos.

### Keywords

bilingualism; Hispanic/Latino; cognitive change; language proficiency

## BACKGROUND

The US Hispanic/Latino population surpassed 62 million in 2020 [1], and the majority of Hispanics/Latinos report some level of Spanish/English bilingualism. Although Spanish language use among Hispanic/Latino individuals has remained relatively stable (70% in 2019 vs 75% in 1980), the proportion of Hispanic/Latino individuals proficient in English (i.e., reporting speaking only English at home or speaking English ‘very well’) has increased from 59% in 1980 to 72% in 2019 [1]. Though increases in English language proficiency may be driven by younger, often US-born Hispanics/Latinos [1], it is still critical to consider levels of language proficiency and patterns of use in mid- to late-life Hispanics/Latinos given that studies suggest bilingualism may delay the behavioral manifestations of adverse cognitive aging including Alzheimer’s disease and related dementias (ADRD) [2].

Empirical evidence surrounding the role of bilingualism on cognitive aging and ADRD is mixed [3]; due, in part, to the common conceptualization of bilingualism as a dichotomous variable (e.g., whether an individual reports speaking Spanish *and* English or only one of these language) [2,4]. As a result, investigators [5–9], including ourselves [10], are studying aspects of the Spanish/English bilingual experience incorporating levels of language proficiency and/or patterns of language use (among other factors) to better characterize dual Spanish/English language capabilities. Most of these investigations suggest higher levels of language proficiency are associated with higher levels of cognitive performance [5,6,8], and that language proficiency and patterns of use differentially relate to domain-specific cognitive functions [7,9,10]. For example, our study of mid- to late-life Hispanics/Latinos found that higher self-reported second-language (English) proficiency was associated with higher levels of cognitive performance regardless of task, but that higher self-reported patterns of both Spanish and English language use were associated with letter fluency and information processing speed but not verbal learning and memory [10]. Much of this work (including ours) was cross-sectional, making it difficult to evaluate the impact of language proficiency and use on cognitive change.

This study builds upon our previous cross-sectional work with the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) to determine the impact of baseline language proficiency and patterns of use on cognition seven years from baseline. Specifically, the

SOL-Investigation of Neurocognitive Aging (SOL-INCA) fielded concurrently with the second HCHS/SOL visit allowed us to test hypotheses based on our previous work. We hypothesized that – similar to baseline associations [10] – higher levels of self-reported second-language (English) proficiency would be associated with higher levels of cognitive performance at the 7-year follow-up visit regardless of cognitive task; and, given the universality of previous associations and that language proficiency may reflect a gestalt of skills [11], it would also be associated with better than predicted cognitive improvements based on 7-year cognitive change from baseline to follow-up. In contrast, given the selectivity of previous associates between patterns of use and cognition [10] and the relative stability of use over time [1], we hypothesized that higher Spanish/English language use would be associated with cognitive tests of executive functioning and processing speed but not verbal learning and memory at follow-up.

## METHODS

The HCHS/SOL [12] is a population-based prospective cohort study designed to examine cardiovascular and other chronic diseases among Hispanic/Latino adults in the US. Baseline data included 16,415 participants, 18–74 years of age, recruited from sites located in four major Hispanic/Latino population centers including: Bronx, NY, Chicago, IL, Miami, FL, and San Diego, CA. The baseline visit (2008–2011) obtained information on sociodemographics, lifestyle habits, medical history, and current health; it also assessed neurocognitive function in 9,623 participants 45–74 years of age at the time of their visit. HCHS/SOL used a multistage sampling technique with stratification, clustering, and unequal probability of selection, and used inverse probability weighting to account for non-response and attrition.

SOL-INCA [13,14], a neurocognitive ancillary study fielded concurrently with the second HCHS/SOL visit (2015 to 2018), recruited HCHS/SOL participants who were age 50 years and older at their follow-up visit and had participated in the baseline neurocognitive module. SOL-INCA also used a multistage sampling scheme with stratification, clustering, and probability weights to account for non-response and attrition. SOL-INCA enrolled 6,377 eligible HCHS/SOL participants; it repeated and expanded upon the brief neurocognitive exam administered at baseline (detailed below).

In keeping with our previous work [10], and our objective to study the bilingual experience while minimizing differences that may exist between native Spanish versus native English speakers and bilingual individuals who have and have not migrated to the US (specifically, the 50 States and DC; US/DC), our sample included only native Spanish speakers reporting their birth and their parents' birth outside of the US/DC. Individuals born in the US territory of Puerto Rico were included in those that 'migrated'; our rationale being that migration to the US/DC includes experiences of acculturation and socioenvironmental determinants for immigrants regardless of their point of origin [15]. Practically, this meant we included individuals who reported speaking only Spanish or Spanish better than English as a child (excluding n=508 individuals) and we excluded those whose preferred language was English at baseline (n=414) and/or follow-up (n=97) visits. We also excluded participants who did

not self-report their birth and their parents' birth outside of the US/DC and individuals who reported their birth within the US/DC (n=168).

We further excluded 211 individuals who self-reported stroke at baseline or follow-up, 530 individuals who reported use of psychotropic medications, and 224 individuals who reported a high level of risk for alcohol use disorder [16] at either visit given that these factors negatively impact cognition [17–19]. Individuals missing data on neurocognitive outcomes (n=220) or covariates (n=42) were also excluded. The final unweighted analytic sample size was 3,963.

## Language proficiency and patterns of use

For our cross-sectional investigation [10], we conducted a review of the literature on ways in which bilingualism was being conceptualized continuously. This information was considered within the context of available information on the bilingual experience at the HCHS/SOL baseline visit. To be consistent with this prior work, we continued to employ the resulting composite scores reflecting Spanish/English language proficiency and patterns of use [10,20].

The language proficiency composite score summed responses from two questions: "In general, what language(s) do you read and speak?" and "What language(s) do you usually speak at home?" Our original assumption, that perceived language proficiency may dictate which language (Spanish and/or English) is used for these daily tasks, was further supported by the fact that the second of these two questions is used by the Pew Center for Research to assist in the determination of language proficiency from Census and American Communities Survey data [1]. Both questions were answered on a 1 to 4 Likert-type scale (1=only Spanish, 4=English better than Spanish); a higher score indicated higher second-language (English) proficiency for native Spanish-speaking persons.

The pattern of language use composite score summed responses from two questions: "In which language(s) do you usually think?" and "What languages do you usually speak with your friends?" Both questions were taken from the Short Acculturation Scale for Hispanics [21] with the assumption being that these questions assessed unconscious and interactive language use, respectively. Both questions were answered on the same Likert-type scale and adhered to the same interpretive direction for native Spanish speaking persons described above.

There was an additional option, a '5' for only English. Given inclusion criteria for the analytic sample, there were few 'only English' responses (n=2). These individuals were excluded.

## Neurocognitive testing

In addition to a brief Six-Item Screener (SIS) that queried general orientation and mental status [22], the tests administered at baseline were the: (1) Brief Spanish English Verbal Learning Test (B-SEVLT; verbal learning and memory); (2) Word (i.e., letter) Fluency (WF); and (3) Digit Symbol Subtest (DSS; processing speed). SOL-INCA repeated these tests at follow-up and also administered the Trail Making Test Part A and B (TMT) measuring

attention and processing speed and, in the case of TMT-B, also working memory. All cognitive tests (baseline and follow-up), were administered by trained clinic staff in English or Spanish using the respondent's self-reported language preference (the current study only included data from respondents tested in Spanish). It should be noted that code-switching during testing (i.e., language alternation between Spanish and English) was not allowed except during the WF task.

For the neurocognitive tests administered at both visits, both test-specific scores and a composite global cognitive change score indicator (reliable change index) were generated using regression-based techniques [23]. These change scores were calculated using survey linear regression to predict cognitive performance at follow-up as a function of cognitive performance at baseline, adjusting for time lapsed (in days) between cognitive assessments. Test specific standardized measures of change (Δ) were subsequently calculated using $(T2 - T2_{pred})/SEE$. $T2$ represents a respondent's score on a cognitive test at follow-up, $T2_{pred}$ is the predicted value for that respondent on the test derived from the regression model specified above, and $SEE$ is Root Mean Squared Error of the fit model. Thus, a positive change score suggests improvements in performance (i.e., better performance than predicted) while negative change scores suggest declines in performance relative to that predicted. A similarly constructed global cognitive change score was created that included all four test-specific measures in its composition.

## Covariates

All covariates were measured at baseline to assess exposure relevant to longer term cognitive outcomes, and to maintain consistency with the timing of the primary exposures. Sociodemographic variables included age, sex, education (i.e., less than high school, high school or equivalent degree, more than high school), and Hispanic/Latino background (i.e., Dominican, Central American, Cuban, Mexican, Puerto Rican, South American, and aggregated 'more than one background' and 'other' responses). Additional covariates included depressive symptoms (the total score of the 10-item version of the Center for Epidemiologic Studies of Depression Scale; CESD-10) [24] given the role of depressive symptomatology in cognition [25]; income (<$20,000, $20,000-$50,0000, >$50,000, and not reported), and years in the US (<10, 10 to ≤15, and 15+ years) both of which can impact acculturation and thus, the bilingual experience. We also adjusted for field center.

## Statistical Analyses

Descriptive statistics were computed for bilingual experience exposures, covariates, and cognitive outcomes. Follow-up cognitive outcomes were standardized (generated using $[Y_i\text{-}Mean\ Y_i]/Standard\ Deviation$) for analyses to facilitate comparison of the estimated associations across models. Linear regression models examined the independent associations between baseline proficiency and patterns of use composite scores (separately) and (a) global cognitive performance at follow-up and (b) change between baseline and follow-up. For each exposure, we fit two models: (1) age adjusted; and (2) age, sex, education, Hispanic/Latino background, CESD-10, income, years in the US, and field center adjusted. These models were then repeated to examine the associations between bilingual experience exposures and each of the cognitive tests. To ensure our findings were not unduly influenced

either by individuals with severe cognitive impairment or individuals from US territories, we conducted separate sensitivity analyses refitting our models either on the subpopulation of individuals scoring greater than 2 on the SIS (range 0–6) at follow-up or excluding Puerto Ricans. All analyses used complex survey procedures with sampling weights, clustering, and stratification to incorporate the complex sampling design.

## RESULTS

As noted in Table 1, the mean age at baseline was 56.1±8.1 years, more than half were female (55.9%), over one-third had less than a high school education (38.9%), nearly half had an income of <$20,000 (46.5%), and over half reported 15+ years in the US (61.9%). As expected given the construction of the analytic sample, the average language proficiency composite score fell between 2 and 3, suggesting a level of language proficiency between 'Spanish better than English' (i.e., a score of 2) and both languages equally (i.e., a score of 3). The same could be said of the average patterns of use composite score. The average score for language used as a child was 1.0±0.1 suggesting a predominantly 'only Spanish' response style. Table 1 also details characterization of the questions that comprised bilingual experience composite scores.

### Global cognition

Regardless of adjustments, baseline language proficiency and patterns of use composite scores (separately) were associated with global cognition at follow-up. In fully-adjusted Model 2, higher levels of second-language (English) proficiency [β estimate=0.055 (standard error=0.015); p<0.001] and patterns of use [β=0.038 (0.010); p<0.001] were associated with higher levels of global cognitive performance seven years after baseline (Figure 1). There was no evidence to link either composite score to 7-year change in global cognition (Table 2).

### Test-specific cognition

Baseline language proficiency and patterns of use were associated with WF and DSS scores at follow-up, regardless of adjustments. In fully-adjusted Model 2, higher levels of second-language (English) proficiency [$\beta_{WF}$=0.105 (0.020), p<0.001; $\beta_{DSS}$=0.097 (0.016), p<0.001] and use [$\beta_{WF}$=0.079 (0.019), p<0.001; $\beta_{DSS}$=0.066 (0.016), p<0.001] were associated with higher levels of performance on both processing speed and letter fluency at the 7-year follow-up. Neither bilingual experience composite was associated with B-SEVLT learning or memory at follow-up (Table 3).

Regardless of adjustments, language proficiency and patterns of use composite scores were associated with TMT Parts A and B at follow-up. In fully-adjusted Model 2, higher levels of second-language (English) proficiency were associated with lower (i.e., better) levels of performance on TMT-A [$\beta_{TMT\text{-}A}$=−0.073 (0.014), p<0.001] and TMT-B [$\beta_{TMT\text{-}B}$=−0.089 (0.019), p<0.001]. A similar profile was seen for patterns of language use and TMT tasks; however, only TMT-B met threshold for significance [fully-adjusted Model 2: $\beta_{TMT\text{-}A}$=−0.030 (0.016), p>0.05; $\beta_{TMT\text{-}B}$=−0.063 (0.017), p<0.001].

When investigating 7-year change, language proficiency and patterns of use were associated with change in WF in the fully-adjusted Model 2. Specifically, higher levels of second-language (English) proficiency [$\beta_{WF}$=0.063 (0.023), p<0.01] and use [$\beta_{WF}$=0.042 (0.021), p<0.05] were both associated with better than predicted 7-year change for letter fluency. The initial negative associations seen between higher patterns of second-language (English) use and more pronounced declines in 7-year change in age-adjusted recall [$\beta_{B\text{-}SEVLT\text{-}Recall}$=−0.047 (0.018); p<0.05] did not withstand further adjustments (Table 3). No other associations were detected.

### Sensitivity Analysis

Results remained relatively unchanged in the subpopulation without evidence of severe cognitive impairment with the exception that p-values for associations between second-language (English) use and TMT-A at follow-up [fully-adjusted Model 2: $\beta_{TMT\text{-}A}$=−0.032 (0.016), p<0.05] and better than predicted 7-year change in letter fluency [fully-adjusted Model 2: $\beta_{WF}$=0.040 (0.021), p>0.05] were reversed from those reported above.

Likewise, results remained relatively unchanged when we excluded individuals who self-identified as Puerto Rican (n=328; given that Puerto Rico is part of the US) with the exception that higher levels of second-language (English) proficiency became associated with better than predicted 7-year change in DSS performance, regardless of adjustment [fully-adjusted Model 2: $\beta_{WF}$=0.061 (0.027), p<0.05], and patterns of use were no longer associated with 7-year change in WF [fully-adjusted Model 2: $\beta_{WF}$=0.042 (0.023), p>0.05].

## DISCUSSION

In this study of nearly 4,000 mid- to late-life Spanish-speaking Hispanic/Latino immigrants participating in HCHS/SOL-INCA, we found that baseline second-language (English) proficiency and patterns of use were associated with level of (but not change in) global cognition at 7-year follow-up. Level results were driven primarily by tests of fluency and processing speed, and further supported by separate findings for attention, information processing, and (to a lesser extent) working memory. Second-language (English) proficiency and use were associated with better than predicted change in letter fluency only; though, an association between language proficiency and better than predicted change in processing speed did result from sensitivity analyses. Together, results suggest that cognitive findings for language proficiency and use – unlike baseline findings [10] - closely mirrored each other at follow-up.

Our study contributes to the literature in several ways. To our knowledge, this is the largest study of the bilingual experience in mid- to late-life Hispanic/Latino bilinguals. Given that this population is expected to increase approximately 160% by 2040 [26] and is at increased risk of dementia compared to non-Hispanic Whites, determining potentially modifiable factors that may improve cognition over time is an important consideration. Second, results confirm reports that higher levels of second language proficiency are associated with higher levels of global cognition and specific cognitive domains (e.g., verbal fluency [6], processing speed, attention, working memory) and extends this work to include associations of patterns of language use with these same cognitive tasks. Third, our study adds to the small

but growing literature [9] investigating associations between second-language proficiency and patterns of use and cognitive change in US-based Hispanics/Latinos finding similar null associations for learning and memory, but novel associations with tests of executive functioning.

Cognitive associates of language proficiency and patterns of use at 7-year follow-up were found on tests assessing fluency, processing speed, attention, and working memory; despite this, these exposures only consistently associated with 7-year change in letter fluency. Some studies report that levels of language proficiency do not differentiate executive control performance in older bilinguals [8]; however, our results and others' [7] suggest otherwise. In fact, we would argue that it is precisely the skills of processing speed, attention, and working memory that are needed for bilingual speakers to appropriately manage their use of different languages in everyday life [10]; a supposition further supported by a recent quantitative review [27]. We noted only one association of second-language (English) proficiency and use with better than expected 7-year cognitive change (in fluency) present regardless of covariates and/or analytic sample exclusions. While the fact that we allowed code-switching during fluency may, at face value, seem to suggest an advantage (e.g., access to a larger vocabulary) for those exploiting this linguistic option, the literature would suggest a disadvantage (i.e., switching between languages "costs" time compared to staying in the same language [28]); Furthermore, code-switching is less likely when a bilingual is working in their dominant/preferred language [29]. Overall, it seems that measuring levels of language proficiency and use may be a way to understand specific aspects of cognition and potential verbally-mediated cognitive change. Thus, investigations of foreign language learning on cognition in older adults [30,31], some of which have found no cognitive benefit [32], may be enhanced by considering aspects of the bilingual experience when screening individuals for study inclusion and/or targeting specific cognitive outcomes.

Underlying mechanisms for our results, while beyond the scope of this study, may be found in the literature. A recent functional MRI (fMRI) study reported that higher second-language proficiency in older bilingual adults was associated with lower levels of prefrontal activation which contributed to neural efficiency for select executive abilities [33]. Furthermore, a review of resting state fMRI literature suggests that this more efficient prefrontal activation seen for bilingual older adults reporting higher second-language proficiency and use results in a reorganization of functional networks (i.e., increased recruitment of posterior and subcortical regions) which may, as a protective 'reserve' mechanism, shield bilingual individuals from normal age-related decreases in recruitment of posterior and subcortical regions; ultimately, delaying age-related cognitive decline through neural plasticity and use [34]. In fact, in our results, although second-language (English) proficiency and use were associated with a better than expected 7-year change score for fluency, average scores were more suggestive of little to no change (i.e., stable performance over time) as opposed to substantial improvement. Thus, higher levels of language proficiency and use may contribute to a longer duration of cognitive performance maintenance rather than a greater increase in cognitive performance over time. More work investigating this, and other [35] potential mechanisms is needed.

This study should be viewed within the context of its limitations. Our measures of language proficiency and use were self-reported, and can be debated. For example, select questions may reflect language preference or seem conceptually interchangeable, particularly when compared against more objective measures of language proficiency [36] published since the time of our baseline study. Future research investigating other approaches to conceptualizing these constructs combined with more objective measures of the bilingual experience planned for the next HCHS/SOL-INCA assessment wave may address inherent limitations in our current classifications. Other limitations include the fact that our bilingual experience composite metrics may be influenced by a myriad of individual, socioenvironmental, and acculturation-related experiences [15] including discrimination and systemic racism as well as differences in occupation, income, and/or language used in the workplace. While we cannot address all of these unmeasured confounders, by including only individuals self-reporting their birth and their parents' birth outside of the US/DC, we attempted to equate many of the factors associated with the acculturation experience [15]. This decision, however, may also limit the generalizability of our results. Lastly, the focus of the original HCHS/SOL study was not cognition [12], thus, our baseline cognitive testing was limited; however, modeled after The Atherosclerosis Risk in Communities Study [37], testing incorporated important outcomes associated with pathological aging and dementia as well as bilingualism.

Study strengths include the fact that our cohort reflected six Hispanic/Latino backgrounds, and included mid- to late-life adults. Additionally, we chose our method of determining 7-year change based on the fact that it corrects for practice effects, retest reliability, and variability in follow-up test scores; it also allowed us to account for time elapsed between cognitive assessments [23]. While more work is needed exploring distinctions in the bilingual experience, our study explores important questions regarding how to conceptualize aspects of this experience generally, and as related to changes in cognitive performance seven years later in a growing yet understudied population of Hispanic/Latino adults.

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## Research in Context

1. Systemic Review: The authors reviewed the literature using traditional (e.g., PubMed) sources and meeting abstracts/presentations to not only define their measures of the bilingual experience, but to focus their review of the literature as these experiences relate to cognition and dementia in mid- to late-life Hispanic/Latino adults.
2. Interpretation: Our study answers important questions regarding how to conceptualize aspects of this experience as it relates to level of and change in cognitive performance seven years later in a growing yet understudied population.
3. Future directions: The manuscript not only suggests ways in which to improve screening tools for intervention studies utilizing foreign language learning in older adults, it discusses ways to increase the generalizability of presented results and objectively conceptualize the bilingual experience as it relates to longitudinal cognitive change.

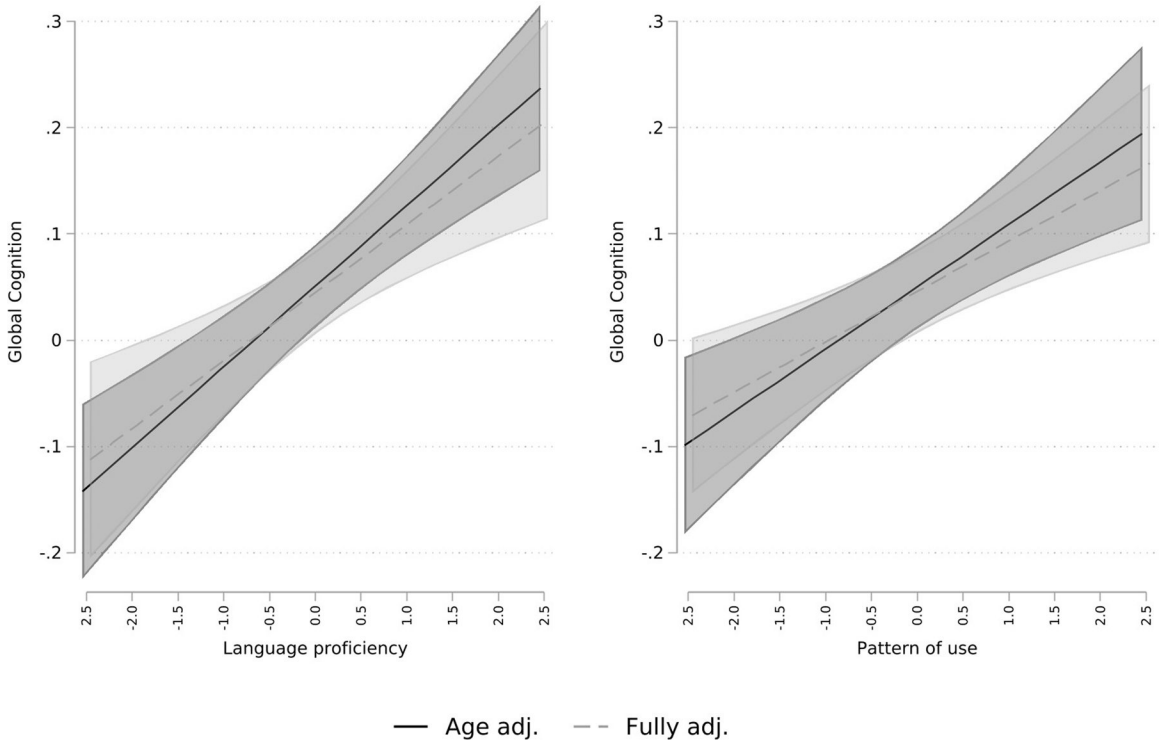


**Figure 1.**

Associations of baseline second-language (English) proficiency (left panel) and patterns of use (right panel) with level of global cognitive performance (standardized measure) at 7-year follow-up in age-adjusted (solid line) and fully-adjusted (dashed line) models that included terms for age, sex, education, Hispanic/Latino background, depressive symptoms, income, years in the US, and field center. Shaded areas represent 95% confidence intervals.

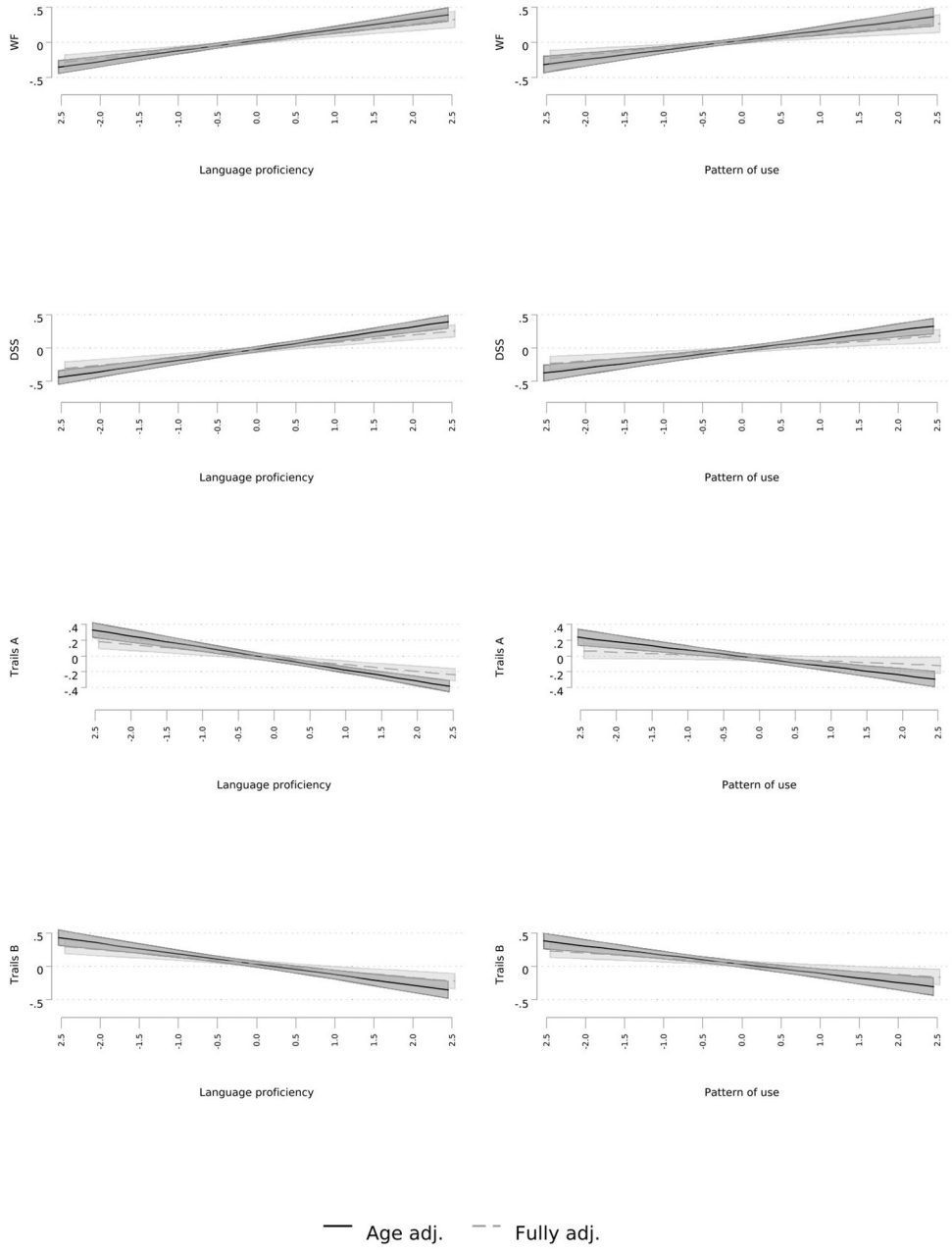


**Figure 2.**

Associations of baseline second-language (English) proficiency (left panel) and patterns of use (right panel) with levels of test-specific cognitive performance at 7-year follow-up [standardized measures of Word Fluency (WF; first row), Digit Symbol Substitution (DSS; second row), and the Trail Making Test (Trails A, third row, and Trails B, fourth row)] in age-adjusted (solid line) and fully-adjusted (dashed line) models that included terms for age, sex, education, Hispanic/Latino background, depressive symptoms, income, years in the US, and field center. Shaded areas represent 95% confidence intervals.

**Table 1.**

Characteristic of the Study of Latinos-Investigation of Neurocognitive Aging population (unweighted n=3,963)

| | Overall |
|---|---|
| **Age, years** | 56.1 (8.1) |
| **Sex (%)** | |
| Female | 55.9 (1.1) |
| Male | 44.1 (1.1) |
| **Education (%)** | |
| Less than high school | 38.9 (1.3) |
| High school or equivalent | 21.9 (1.0) |
| Greater than high school | 39.2 (1.2) |
| **Hispanic/Latino Background (%)** | |
| Dominican | 10.1 (0.9) |
| Central American | 8.9 (0.7) |
| Cuban | 27.7 (2.1) |
| Mexican | 35.4 (2.0) |
| Puerto-Rican | 7.8 (0.7) |
| South American | 6.6 (0.5) |
| More than one background/Other | 3.4 (0.6) |
| **CESD-10 score** | 6.6 (6.0) |
| **Income (%)** | |
| <$20k | 46.5 (1.5) |
| $20k-$50k | 37.0 (1.2) |
| >$50k | 7.7 (0.9) |
| not reported | 8.8 (0.7) |
| **Years in the US (%)** | |
| < 10 years | 26.1 (1.3) |
| 10 to 15 years | 12.0 (0.7) |
| 15+ years | 7.7 (0.9) |
| **Field Center (%)** | |
| Bronx | 21.8 (1.6) |
| Chicago | 13.9 (1.1) |
| Miami | 40.7 (2.5) |
| San Diego | 23.7 (1.9) |
| **Language proficiency composite score** | 2.79 (1.16) |
| Language(s) read & speak | 1.47 (0.66) |
| Language(s) speak at home | 1.31 (0.69) |
| **Patterns of use composite score** | 2.69 (1.24) |
| Language to think | 1.29 (0.69) |
| Language spoken with friends | 1.40 (0.75) |

Note: All variables are from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) baseline visit and represent mean and standard deviation unless otherwise noted. CESD-10=Center for Epidemiologic Studies of Depression scale. Language proficiency and patterns of use individual and composite scores used a 1 to 4 Likert scale where 1 indicated only Spanish and 4 indicated English better than Spanish.

**Table 2.**

Associations of baseline language proficiency and patterns of use with 7-year level and change in global cognition

| Model | | Global Cognition | ΔGlobal Cognition |
|---|---|---|---|
| | | beta (standard error) | beta (standard error) |
| 1A | **Language proficiency** | 0.065*** (0.012) | 0.003 (0.025) |
| 1B | **Patterns of use** | 0.047*** (0.012) | −0.013 (0.017) |
| 2A | **Language proficiency** | 0.055*** (0.015) | 0.049 (0.027) |
| 2B | **Patterns of use** | 0.038*** (0.010) | 0.024 (0.017) |

Note: Model 1 adjusted for age only; Model 2 adjusted for age, sex, education, Latino background, depressive symptoms, income, years in the US, and field center.

*** p<0.001.

**Table 3.**

Associations of baseline language proficiency and patterns of use with 7-year level and change in test-specific scores

| Model | | B-SEVLT Sum | ΔB-SEVLT Sum | B-SEVLT Recall | ΔB-SEVLT Recall | Word Fluency | ΔWord Fluency | DSS | ΔDSS |
|---|---|---|---|---|---|---|---|---|---|
| | | b/se | b/se | b/se | b/se | b/se | b/se | b/se | b/se |
| 1A | **Language proficiency** | 0.006 (0.016) | −0.025 (0.020) | −0.018 (0.019) | −0.041 (0.021) | 0.129*** (0.017) | 0.041 (0.022) | 0.144*** (0.017) | 0.032 (0.021) |
| 1B | **Patterns of use** | −0.012 (0.016) | −0.047* (0.018) | −0.022 (0.017) | −0.039* (0.017) | 0.109*** (0.020) | 0.031 (0.020) | 0.113*** (0.019) | 0.024 (0.018) |
| 2A | **Language proficiency** | 0.021 (0.019) | 0.021 (0.022) | −0.002 (0.024) | −0.005 (0.024) | 0.105*** (0.020) | 0.063** (0.023) | 0.097*** (0.016) | 0.045 (0.025) |
| 2B | **Patterns of use** | 0.007 (0.017) | −0.007 (0.022) | 0.001 (0.020) | −0.003 (0.019) | 0.079*** (0.019) | 0.042* (0.021) | 0.066*** (0.016) | 0.036 (0.020) |

Note: B-SEVLT=Brief Spanish English Verbal Learning Test; Δ=change; DSS=Digit Symbol Substitution.

Model 1 adjusted for age only; Model 2 adjusted for age, sex, education, Latino background, depressive symptoms, income, years in the US, and field center.

* p<0.05;

** p<0.01;

*** p<0.001.

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