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RESEARCH ARTICLE

Normative data for the Brief Spanish-English Verbal Learning Test for representative and diverse Hispanics/Latinos: Results from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

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Abstract

Introduction: Episodic learning and memory performance are crucial components of cognitive assessment. To meet the needs of a diverse Hispanic/Latino population, we aimed to provide normative data on the Brief Spanish-English Verbal Learning Test (B-SEVLT).

Methods: The target population for the Hispanic Community Health Study/Study of Latinos (HCHS/SOL) included individuals 45+ years old from Central American, Cuban, Dominican, Mexican, Puerto Rican, and South American backgrounds. Average age was 56.5 years ± 9.92, 54.5% were female, and mean education was 11.0 years ± 5.6 (unweighted $n = 9309$). Participants were administered the B-SEVLT in their preferred language (Spanish or English). Hispanic/Latino background adjusted B-SEVLT scores and percentile cut-points were created using survey-adjusted regression models.

Results: Higher educational attainment, younger age, and being female were associated with higher learning and memory performance. Hispanic/Latino background groups differed in B-SEVLT performance.

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Discussion: Representative learning and memory norms for Hispanic/Latinos of diverse backgrounds will improve cognitive assessment and accuracy of neurocognitive disorder diagnosis.

KEYWORDS
aging, disparities, Hispanic American, memory, neuropsychology, sex

1 | INTRODUCTION

Between 2010 and 2019, Hispanics/Latinos made up over half of the US population growth.[1] Hispanics/Latinos are a diverse population that varies linguistically, culturally, and genetically.[2–4] Rates of mild cognitive impairment, a risk factor for Alzheimer's disease (AD), varies by Hispanic/Latino background group (e.g., Cubans, Puerto Ricans),[5] yet it has been the practice to aggregate Hispanics/Latinos into one group when applying normative data and generalize research results from one group (e.g., Mexican Americans) to another (e.g., Dominicans). As an alternative to this practice, population-specific demographically adjusted normative data are crucial in properly evaluating cognitive functioning and avoiding inappropriate inferences and misdiagnoses.[6–9] Unfortunately, there is a dearth of cognitive test normative data that account for the diversity of the Hispanic/Latino population. Filling these gaps in normative cognitive test data for populations facing health disparities was Priority 1 identified at the 2019 Alzheimer's Disease and Related Dementias (ADRD) Summit.[10]

Episodic verbal learning and memory assessments are essential in diagnosing preclinical to moderate ADRD and other pathologies.[11–14] Although several verbal list learning and memory tests exist, few provide normative data from large and representative samples of diverse Hispanics/Latinos.[9,15–17] Díaz-Santos et al. provided normative data for the Hopkins Verbal Learning Test-Revised (HVLT-R) based on 203 monolingual Spanish speakers ages 19 to 60 years old from the United States–Mexico border regions of Arizona and California.[18] While these data provided norms for an underserved linguistic minority, the applicability of these norms to older Hispanics/Latinos and to those with different regional and linguistic backgrounds is limited. O'Bryant et al. reported normative data for the Rey Auditory Verbal Learning Test based on a sample of 387 community-dwelling Mexican Americans who were 40 years and older.[19] A strength of their data was stratification by education and age (40–60 years and 61+ years) as well as inclusion of Spanish and English speakers. However, their sample was limited to Mexican Americans from Texas. In a more geographically expansive study, Arango-Lasprilla et al. reported normative data for the HVLT-R on 3972 healthy adults from 11 countries in Latin America, with country-specific adjustments for sex, age, and education.[20] Although their sample was large and diverse, the applicability to US Hispanics/Latinos is uncertain.

The Spanish-English Verbal Learning Test (SEVLT) is a verbal episodic learning and memory test that was developed for Hispanics/Latinos in northern California. This 15-item word list learning and memory test can be administered in English or Spanish.[21] The SEVLT consists of five learning trials, an interference trial with a different 15-word list, and a post-interference recall trial for the original word list. Initial normative data for the SEVLT were based on 801 English- and Spanish-speaking Hispanics/Latinos ages 60 years and older who were primarily of Mexican background (n = 689).[21] Sensitivity to cognitive impairment was comparable between the SEVLT English and Spanish versions, and this held in their larger sample of 1686 Hispanics/Latinos from the Sacramento Area Latino Study on Aging (SALSA).[22] Although SEVLT normative data are based on considerable sample sizes and are sensitive to global cognitive functioning, their applicability to Hispanics/Latinos from diverse backgrounds across the United States has not been reported.

To expand normative data to diverse Hispanics/Latinos, González et al. administered a brief version of the SEVLT (the B-SEVLT) to more than 9000 Hispanics/Latinos from six different Hispanic/Latino backgrounds in the Hispanic Community Health Study/Study of Latinos (HCHS/SOL).[23] The B-SEVLT uses three learning trials rather than five to reduce participant burden. They reported differences by Hispanic/Latino background; however, normative B-SEVLT data were not provided for Hispanic/Latino backgrounds. Therefore, the present study sought to generate normative data for the B-SEVLT from the HCHS/SOL, which is the largest and most diverse study of cognitive aging among middle-aged and older Hispanics/Latinos within the United States to date.

2 | METHODS

2.1 | Study sample

We used data from the HCHS/SOL, a multisite, probability sampled, prospective cohort study. Data were collected at field centers in four US metropolitan areas with high Hispanic/Latino population densities (Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA). Each field center recruited approximately 4000 eligible, self-identified Hispanic/Latino adults (18–74 years old; n = 16,415) at baseline (i.e., Visit 1; 2008–2011). Detailed HCHS/SOL sampling procedures have been published elsewhere.[24,25] Institutional review boards at Albert Einstein College of Medicine, University of Illinois at Chicago, San Diego State University, University of Miami, and University of North Carolina approved the study. All participants provided informed consent. Individuals who were 45 years and older were invited to complete a neuropsycholog-

ical testing battery that included four tests–the B-SEVLT, Word Fluency, Digit Symbol Substitution, and the Six-Item Screener (SIS).[23] For the purposes of this study, we focused on the B-SEVLT (unweighted n = 9623). We excluded 187 participants who did not report a specific Hispanic/Latino background, and 117 individuals missing data on the covariates of interest. Our unweighted analytic sample size was n = 9309. To determine whether our normative data are robust, we included individuals who self-reported stroke/transient ischemic attack (TIA; n = 261) and who had low cognitive status (total SIS[26] score ≤ 4; n = 1439). Individuals with SIS > 4 were considered cognitively normal (CN). The cut-off score of > 4 on the SIS was made on a threshold of approximately the 16th percentile of the overall sample. In secondary analyses we excluded individuals with SIS ≤ 4 and who self-reported stroke/TIA. The unweighted analytic sample size for these analyses were n = 7609.

RESEARCH IN CONTEXT

1. **Systemic review**: The authors reviewed literature pertaining to normative data available for Spanish- and English-speaking Hispanics/Latinos using traditional sources (e.g., PubMed).
2. **Interpretation**: Demographic factors, such as sex and background (e.g., Mexican) were associated with differences in learning and memory for Hispanics/Latinos.
3. **Future directions**: The influence of sociocultural factors (e.g., bilingualism, acculturation) on the relationships between demographics and learning and memory among Hispanics/Latinos should be investigated.

2.2 | Outcomes

The B-SEVLT consists of 15 shopping-list items derived from the SEVLT. Items were objects that could be purchased in a store and had an English and Spanish version that were direct translations of one another. To develop the list, items were first translated from English to Spanish and then the resulting Spanish versions were independently translated back to English. A committee compared the original English and back-translated English versions, and when discrepancies were present, arrived at a consensus about the most appropriate translation. The word list encompassed five semantic categories with five vegetables, four beverages, three kitchen utensils, two reading materials, and one fruit. Items were selected based upon English and Spanish language prototypicality norms for semantic categories.[21]

Testing procedures for the B-SEVLT followed a standard word-list learning test format. On each of three trials, words were presented orally at a rate of one word per second (List A) with immediate free recall after each complete list presentation. Word list order was fixed across trials and was arranged so that two words from a given semantic category were not presented consecutively. After the three List A learning trials, an interference trial occurred in which a different 15-word list was presented and recalled (List B; see supporting information). Immediately after the interference trial, free recall of List A words was elicited (i.e., post-interference recall). For this study, we model the three learning trials and their sum (B-SEVLT Sum), and the post-interference trial (B-SEVLT Recall). These measures assess verbal episodic learning and memory, respectively.[21] Participants were allowed to respond in both English and Spanish across all trials regardless of language of test administration. Responses in "Spanglish" were considered incorrect.

Testing was conducted by bicultural and bilingual (English and Spanish) staff members using the participants' preferred language. To ensure uniformity across testing sites, test administrators were trained by licensed neuropsychologists, and quality assurance was monitored by two licensed neuropsychologists.

2.3 | Covariates

We sought to determine how age, sex, Hispanic/Latino background, education, and language preference were associated with the B-SEVLT performance. Age was accounted for continuously in years, and years of education was measured continuously for modeling and grouped using a trichotomous indicator (< 12, 12, > 12 years) for prediction purposes. Sex (male, female) and language preference at testing (English or Spanish) were binary measures. Hispanic/Latino background included the aforementioned six groups.

2.4 | Analytical procedures

We first report the demographic characteristics of the target population by Hispanic/Latino background and language preference. Categorical measures are reported in percentages, and continuous measures as means (standard deviations [SDs]). Reported *P*-values are for differences in reported measures by background and language preference.

Second, we plotted the overall distributions of B-SEVLT scores for the individual learning trials, the sum of trials, and recall. To facilitate interpretation, we then reported overall normative scores for the trials, including means and SDs by age groups, sex, education, Hispanic/Latino background, and language preference. We plotted the learning (across the three trials) and recall profiles by three age groups (45–59, 60–69, and 70+ years) and three educational attainment categories (< 12, 12, and > 12 years). These plots highlight the differences between four groups: (1) low cognitive status (SIS ≤ 4) with no self-reported stroke/TIA, (2) low cognitive status with stroke/TIA, (3) CN with no stroke/TIA, and (4) CN with stroke/TIA.

Third, we generated survey-adjusted correlation plots to characterize the strength and directions of associations between B-SEVLT measures, age, education, and SIS.

Fourth, we fit survey linear regression models to estimate the adjusted associations between B-SEVLT trials 1 through 3, sum of trials and delayed recall scores and age, sex, education, language preference,

and Hispanic/Latino background. We reported unstandardized beta coefficients to allow interpretation on the original metrics of the outcomes and model covariates with their respective *P*-values. We fit the survey linear regression models for two target populations: (1) all individuals 45 to 74 years of age, and (2) CN individuals 45 to 74 years old with no self-reported stroke/TIA. We then used post hoc techniques to compute normed average marginal estimates derived from the regression models and their 95% confidence intervals (CIs) for males and females within age and education groups. These models were based on the target population of: (1) all individuals 45 to 74 years of age, and (2) CN individuals 45 to 74 years with no self-reported stroke/TIA.

Fifth, we refit the models described in step 4 for individuals 45 to 74 years old stratified by Hispanic/Latino background and excluding background as a model covariate. As above, we used post hoc techniques to compute Hispanic/Latino background-specific normed average marginal estimates derived from the regression models and their 95% CI for males and females within age (45–59 years; 60–69 years; and 70+ years) and education (< 12, 12, and > 12 years) groups.

For steps 4 and 5 above, and to facilitate clinical interpretation, we provide a companion dashboard (please see the following link: https://solincalab.shinyapps.io/B-SEVLT_Norm_Calculator/)[27] to allow readers/users to generate raw score predictions based on individual profiles of interest (e.g., predicted score for a 56-year old, Mexican-origin female, with 9 years of education, and Spanish as a language of preference). These estimates can be generated based on models for the overall population, as well as models estimated within groups defined by Hispanic/Latino background. Estimates can be generated based on the overall target population of individuals 45 years and older, as well as for those with CN status and no self-reported stroke/TIA. The dashboard also allows users to calculate and plot standardized scores (SS; z-scores) for prespecified B-SEVLT trials and recall raw scores. The standardized scores would allow potential users to compare a set of hypothetical raw scores of an individual meeting specific age, sex, education, language, and Hispanic/Latino background criteria relative to the normative distribution given their model expected value. SSs are generated using the following formula: SS = (Raw Score—Expected Value)/RMSE, whereby SS = calculated z-score(s), Raw Score = hypothetical value(s) on a B-SEVLT trial or recall text, Expected Value = model based estimate using the test specific regression equation ($\beta_{Intercept} + \beta_{Age} * Age + \beta_{Sex} * Sex + \beta_{Education} * Education + \beta_{Background} * Background + \beta_{Language} * Language$), and RMSE = root mean square error of estimated regression model. As with above, these SSs can be generated for the overall target population (45 years and older), as well as for individuals with CN status and no self-reported stroke TIA. Scores can also be generated based on the normative distributions of specific Latino background groups.

2.5 | Sensitivity models

In sensitivity analyses we introduced an additional covariate measuring patterns of language use calculated as the average response (1 = "only Spanish," 2 = "Spanish better than English," 3 = "both equally," 4 = "English better than Spanish," 5 = "only English") to two questions: (1) "In which language(s) do you usually think?" and (2) "What language(s) do you usually speak with your friends?" We obtained the questions from the Short Acculturation Scale for Hispanics (SASH).[28] We focused on patterns of language use because previous research has shown potential links to higher levels of cognitive performance specific to memory and learning but less so to processing speed and executive function.[29] In these analyses we refit the models, as specified above for trials 1 through 3, the sum of trials, and the recall measure additionally adjusting for language use. For each cognitive outcome, we fit the models using the overall population, as well as the subpopulation of individuals with CN status and no self-reported stroke or TIA. The unstandardized beta coefficients derived from these models and their respective *P*-values are presented in Table S2 in supporting information. We fit the survey linear regression models for two target populations: (1) all individuals 45 to 74 years of age, and (2) CN individuals 45 to 74 years old with no self-reported stroke/TIA. The normed average marginal estimates derived from the regression models and their 95% CIs for males and females within age and education groups are presented in Table S3 in supporting information.

3 | RESULTS

Average age was 56.5 years (SD = 9.9), and 54.5% were female. In line with the target population, Hispanics/Latinos of Mexican background comprised nearly one third (31.4%) of the sample, followed by Cubans (28%), Puerto Ricans (18.7%), Dominicans (9.5%), Central Americans (6.8%), and South Americans (5.6%). Average years of education was 11.0 (SD = 5.6) with close to two in five individuals (40.1%) reporting less than high school education (< 12 years). Spanish was chosen as the preferred language by 86% of participants. The mean SIS score was 5.3 (range = 0–6; SD = 1.1). We found statistically significant variations in age, education, sex, and SIS distributions by Hispanic/Latino background and language preference. Cubans were slightly older (mean age 58.3 years, SD = 8.2) than other background groups. Cubans (12.2 years, SD = 4.1) and South Americans (12.3 years; SD = 5.9) had higher education relative to other background groups. Higher education was noted among individuals with English as their preferred language for testing (12.8 years; SD = 3.9 vs. 10.7 years; SD = 5.7). Population characteristics by Hispanic/Latino background and language preference for testing are presented in Table 1.

Overall average scores for individual trials 1, 2, and 3, the sum of these trials, and post-interference recall scores are reported in Table 2. The distribution of raw scores were indicative of a curvilinear fit with learning over the three initial trials and lower average scores at post-interference recall (Figure S1 in supporting information). Group means and SDs of raw scores by age, education, Hispanic/Latino background, language preference, and sex are included in Table 2. Females scored significantly higher than males on average. Higher educational attainment was associated with higher scores on the individual trials, the sum of trials, and the post-interference recall trial. Older age was inversely and consistently associated with lower B-SEVLT scores. Inspection of

TABLE 1 Target population characteristics by language preference and Hispanic/Latino background: Results from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

		Female	Age (in years)		Education (in years)		SIS (range = 0-6)	
	Unweighted n	%	Mean	SD	Mean	SD	Mean	SD
Language								
Spanish	8077	55.4	56.9	10	10.7	5.7	5.3	1.1
English	1232	49.2	53.8	8.5	12.8	3.9	5.4	1
P-value language		0.012	<0.001		<0.001		0.002	
Hispanic/Latino background								
Dominican	844	60.2	55.5	9.2	10.5	5.4	5.1	1.2
Central American	938	60.9	55.7	11.7	10	7.5	5.3	1.2
Cuban	1572	48.8	58.3	8.2	12.2	4.1	5.4	0.8
Mexican	3538	56.1	55.3	10.3	9.9	6.6	5.4	1.1
Puerto-Rican	1772	53.8	56.8	9.9	11.3	4.4	5.1	1.3
South American	645	59.4	55.8	10.5	12.3	5.9	5.3	1.1
P-value background		<0.001	<0.001		<0.001		<0.001	

Abbreviations: SD, standard deviation; SIS, Six-Item Screener.
Note: Reported *P*-values are for differences in reported measures by background and language preference.

TABLE 2 Brief Spanish-English Verbal Learning Test (B-SEVLT) learning and recall trials raw scores descriptive statistics by age, sex, education, Hispanic/Latino background, and language preference

	Trial 1	Trial 2	Trial 3	Sum of trials	Recall
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Overall target population	5.1 (2.1)	7.9 (2.8)	9.4 (3.0)	22.3 (6.9)	8.0 (3.6)
Age					
45–59 years	5.3 (2.2)	8.2 (2.9)	9.8 (3.0)	23.3 (7.1)	8.5 (3.6)
60–69 years	4.8 (1.9)	7.4 (2.5)	8.8 (2.7)	21.0 (6.1)	7.3 (3.2)
70+ years	4.4 (1.6)	6.7 (2.1)	8.0 (2.4)	19.1 (5.4)	6.5 (2.8)
Sex					
Female	5.3 (2.3)	8.2 (3.0)	9.8 (3.1)	23.3 (7.3)	8.5 (3.8)
Male	4.8 (1.9)	7.5 (2.5)	8.9 (2.7)	21.2 (6.2)	7.5 (3.1)
Education					
Less than high school	4.6 (2.1)	7.2 (2.8)	8.6 (3.1)	20.5(6.9)	7.2 (3.7)
High school	5.1 (2.0)	7.8 (2.6)	9.3 (2.8)	22.2 (6.4)	7.9 (3.6)
More than high school	5.6 (2.0)	8.6 (2.6)	10.2 (2.7)	24.3 (6.3)	8.9 (3.1)
Hispanic/Latino background					
Dominican	5.3 (2.0)	7.9 (2.6)	9.2 (2.8)	22.4 (6.3)	7.6 (3.6)
Central American	5.2 (2.7)	8.1 (3.2)	9.7 (3.5)	22.9 (8.2)	8.5 (4.0)
Cuban	4.9 (1.5)	7.6 (2.1)	9.1 (2.3)	21.6 (5.2)	7.7 (2.5)
Mexican	5.2 (2.4)	8.2 (3.1)	9.9 (3.2)	23.3 (7.6)	8.7 (3.8)
Puerto Rican	4.9 (2.2)	7.4 (2.8)	8.7 (3.0)	21.0 (7.1)	7.1 (3.9)
South American	5.4 (2.4)	8.4 (2.9)	10.1 (3.0)	23.9 (7.1)	8.8 (3.7)
Language preference					
Spanish	5.0 (2.1)	7.8 (2.8)	9.3 (3.0)	22.2 (6.9)	8.0 (3.5)
English	5.2 (2.2)	8.1 (2.8)	9.6 (2.9)	23.0 (6.9)	8.2 (3.7)

Abbreviation: SD, standard deviation.
Note: Estimates are weighted for appropriate generalization to the target population.

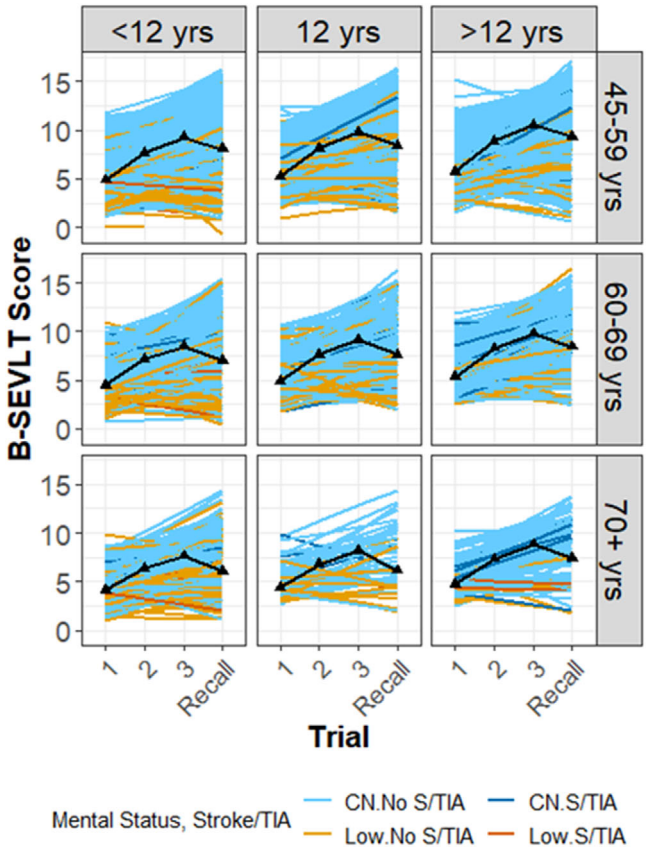

FIGURE 1 Profiles of B-SEVLT performance over the three learning trials and recall trial by age (rows), educational groups (columns), and cognitive status (based on the Six-Item Screener ≤4) and self-reported stroke/TIA (see legend below). Black curved lines denote average performance for each trial and recall. B-SEVLT = Brief Spanish-English Verbal Learning Test; CN = cognitively normal (Six-Item Screener > 4); Low = low cognitive status (Six-Item Screener ≤ 4); S/TIA = stroke/transient ischemic attack; yrs = years

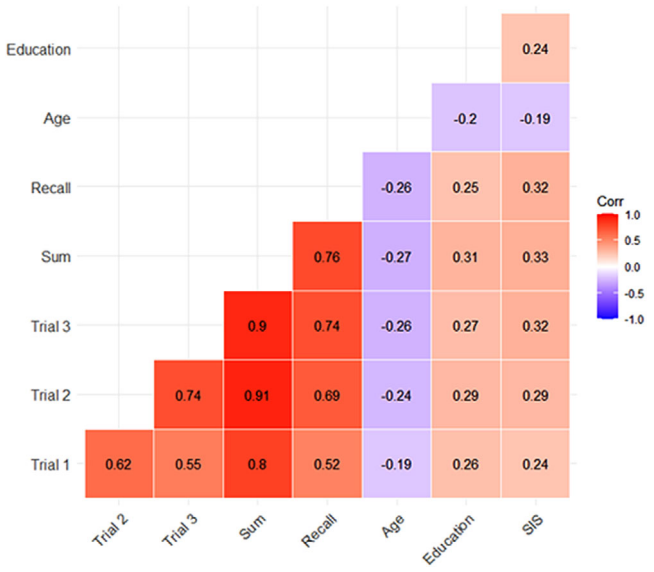

FIGURE 2 Correlation plot of Brief Spanish-English Verbal Learning Test (B-SEVLT) individual trials, sum, and recall; age; education; and Six-Item Screener (SIS) score

profile plots (see Figure 1) indicated wide variations in both intercepts and slopes of change across the three learning trials between individuals, and across age, education, cognitive status as defined by the SIS, and stroke/TIA groupings. See Figure 2 for survey-adjusted correlation plots of the associations among B-SEVLT measures, age, education, and SIS.

Estimates of the adjusted unstandardized beta coefficients derived from the survey linear regression models are presented in Table 3. Each additional year of age was associated with decrements in trials 1 through 3 (−0.03, −0.05, −0.06), sum of trials (−0.13), and in post-interference recall (−0.07; all *P*s < .001). Females had consistently higher scores than males. Education was positively and consistently linked to performance whereby each additional year of educational achievement was associated with 0.10-, 0.14-, 0.14-, 0.38-, and 0.16-unit increments in trials 1 through 3, sum of trials, and recall measures, respectively (all *P*s < .001). Spanish versus English language preference for testing did not differ on any measure. All estimates remained consistent in the CN subpopulation free of stroke or TIA (Table 3, Panel B). Average marginal estimates derived from the survey linear regression models for the overall population and the CN subpopulation show decrements in cognitive scores by older age for males and females and educational achievement (see Table 4). Raw score predictions based on individual profiles as well as z-scores can be calculated using the companion dashboard (https://solincalab.shinyapps.io/B-SEVLT_Norm_Calculator/).[27] Equivalent estimates derived from Hispanic/Latino background stratified models are presented by age, education, and sex in Table S1 in supporting information.

3.1 | Sensitivity results

The results from the models adjusting for patterns of language use were qualitatively and quantitatively equivalent to the primary models (Tables S2, S3). Pattern of language use was not significantly associated with the individual trials, the sum of trials, or the recall measure (Table S2). This was true in both the overall population, as well as the subpopulation of individuals with CN and no self-reported stroke/TIA.

4 | DISCUSSION

Our study provides normative data for Hispanics/Latinos from six different backgrounds for a verbal learning and memory test with comparable Spanish and English versions. These normative data are derived from the largest and most diverse sample of mid- to late-life Hispanics/Latinos in the United States reported to date. Moreover, our complex sampling procedure ensures that the normative data are representative of the target populations examined. In addition, we sampled a significant number of middle-aged and elderly adults, which allowed us to capture cognitive aging and potentially

TABLE 3 Regression estimates of the associations between covariates and B-SEVLT trials for (A) overall target population 45–74 years, and (B) cognitively normal (SIS > 4) individuals 45–74 years, no self-reported stroke/TIA

PANEL A					
	Unstandardized beta coefficients				
	B-SEVLT				
	Trial 1	Trial 2	Trial 3	Sum of trials	Recall
Age (in years)	−0.03***	−0.05***	−0.06***	−0.13***	−0.07***
Sex					
Female	ref	ref	ref	Ref	ref
Male	−0.48***	−0.83***	−0.93***	−2.23***	−1.05***
Education (in years)	0.10***	0.14***	0.14***	0.38***	0.16***
Hispanic/Latino background					
Dominican	−0.01	−0.41***	−0.75***	−1.17***	−1.29***
Central American	−0.07	−0.19	−0.23*	−0.5	−0.26*
Cuban	−0.42***	−0.73***	−0.89***	−2.03***	−1.14***
Mexican	ref	ref	ref	Ref	ref
Puerto Rican	−0.45***	−0.95***	−1.31***	−2.70***	−1.77***
South American	−0.03	−0.12	−0.14	−0.28	−0.35*
Language					
Spanish	ref	ref	ref	Ref	ref
English	0.01	0.06	0.12	0.19	0.1
Intercept	5.99***	9.80***	12.05***	27.87***	11.40***
PANEL B					
	Unstandardized beta coefficients				
	B-SEVLT				
	Trial 1	Trial 2	Trial 3	Sum of trials	Recall
Age (in years)	−0.02***	−0.04***	−0.05***	−0.12***	−0.06***
Sex					
Female	ref	ref	ref	Ref	ref
Male	−0.49***	−0.81***	−0.89***	−2.19***	−1.04***
Education (in years)	0.10***	0.14***	0.14***	0.38***	0.15***
Hispanic/Latino background					
Dominican	−0.02	−0.31**	−0.74***	−1.07***	−1.18***
Central American	−0.03	−0.22	−0.16	−0.4	−0.18
Cuban	−0.48***	−0.76***	−0.90***	−2.14***	−1.13***
Mexican	ref	ref	ref	Ref	ref
Puerto Rican	−0.35***	−0.81***	−1.18***	−2.27***	−1.56***
South American	−0.08	−0.19	−0.28	−0.49	−0.44*
Language					
Spanish	ref	Ref	ref	Ref	ref
English	0.01	−0.01	0.06	0.06	0.08
Intercept	5.82***	9.62***	11.82***	27.26***	11.08***

Abbreviations: B-SEVLT, Brief Spanish-English Verbal Learning Test; ref, reference group; SIS, Six-Item Screener; TIA, transient ischemic attack.
* = $P < .05$; ** = $P < .01$; *** = $P < .001$.

TABLE 4 Brief Spanish-English Verbal Learning Test (B-SEVLT) learning and recall trials average marginal estimates and [95% confidence intervals] derived from regression models for (A) overall target population 45+ years and older and (B) cognitively normal (Six-Item Screener scores > 4) 45+ years and who did not self-report stroke/TIA

PANEL A	Sex					
	Female			Male		
	Education					
	<12 years	12 years	>12 years	<12 years	12 years	>12 years
Trial 1						
Age 45–59 years	5.0 [4.9;5.1]	5.4 [5.4;5.5]	5.9 [5.8;6.0]	4.5 [4.4;4.6]	5.0 [4.9;5.1]	5.5 [5.3;5.6]
60–69 years	4.6 [4.5;4.7]	5.1 [4.9;5.2]	5.5 [5.4;5.6]	4.2 [4.0;4.3]	4.6 [4.5;4.7]	5.1 [4.9;5.2]
70+ years	4.3 [4.1;4.5]	4.7 [4.5;4.9]	5.2 [5.0;5.4]	3.8 [3.6;4.0]	4.3 [4.1;4.5]	4.7 [4.5;5.0]
Trial 2						
Age 45–59 years	7.8 [7.7;8.0]	8.5 [8.4;8.6]	9.1 [9.0;9.3]	7.0 [6.9;7.2]	7.7 [7.6;7.8]	8.4 [8.2;8.5]
60–69 years	7.2 [7.1;7.4]	7.9 [7.7;8.0]	8.5 [8.4;8.7]	6.4 [6.3;6.6]	7.1 [7.0;7.3]	7.8 [7.6;7.9]
70+ years	6.6 [6.4;6.8]	7.3 [7.0;7.5]	7.9 [7.7;8.2]	5.8 [5.6;6.1]	6.5 [6.2;6.7]	7.2 [6.9;7.4]
Trial 3						
Age 45–59 years	9.4 [9.2;9.5]	10.1 [10.0;10.2]	10.8 [10.7;10.9]	8.5 [8.3;8.6]	9.2 [9.1;9.3]	9.9 [9.8;10.1]
60–69 years	8.6 [8.5;8.8]	9.4 [9.2;9.5]	10.1 [9.9;10.2]	7.8 [7.6;7.9]	8.5 [8.3;8.6]	9.2 [9.0;9.4]
70+ years	7.9 [7.6;8.2]	8.6 [8.3;8.9]	9.4 [9.0;9.7]	7.0 [6.8;7.3]	7.8 [7.5;8.0]	8.5 [8.2;8.8]
Sum of trials						
Age 45–59 years	22.2 [21.9;22.5]	24.0 [23.8;24.3]	25.8 [25.5;26.1]	20.1 [19.8;20.4]	21.9 [21.7;22.2]	23.8 [23.4;24.1]
60–69 years	20.5 [20.1;20.9]	22.3 [22.0;22.6]	24.1 [23.7;24.5]	18.4 [18.0;18.8]	20.2 [19.9;20.6]	22.0 [21.6;22.5]
70+ years	18.8 [18.2;19.4]	20.6 [20.0;21.3]	22.5 [21.7;23.2]	16.7 [16.1;17.3]	18.6 [17.9;19.2]	20.4 [19.6;21.1]
Recall						
Age 45–59 years	8.1 [7.9;8.2]	8.8 [8.7;9.0]	9.6 [9.5;9.8]	7.1 [6.9;7.2]	7.9 [7.7;8.0]	8.6 [8.5;8.8]
60–69 years	7.2 [7.0;7.3]	7.9 [7.7;8.1]	8.7 [8.5;8.9]	6.2 [6.0;6.4]	6.9 [6.8;7.1]	7.7 [7.5;7.9]
70+ years	6.4 [6.1;6.7]	7.2 [6.9;7.5]	8.0 [7.6;8.3]	5.5 [5.1;5.8]	6.2 [5.9;6.5]	7.0 [6.6;7.3]
PANEL B	**Sex**					
	Female			Male		
	Education					
	<12 years	12 years	>12 years	<12 years	12 years	>12 years
Trial 1						
Age 45–59 years	5.0 [4.9;5.1]	5.5 [5.4;5.6]	5.9 [5.8;6.0]	4.6 [4.5;4.7]	5.0 [5.0;5.1]	5.5 [5.4;5.6]
60–69 years	4.6 [4.5;4.8]	5.1 [5.0;5.2]	5.5 [5.4;5.7]	4.2 [4.1;4.3]	4.6 [4.5;4.8]	5.1 [4.9;5.2]
70+ years	4.4 [4.2;4.6]	4.8 [4.6;5.1]	5.3 [5.0;5.5]	3.9 [3.7;4.2]	4.4 [4.2;4.6]	4.8 [4.6;5.1]
Trial 2						
Age 45–59 years	7.9 [7.8;8.0]	8.5 [8.5;8.6]	9.2 [9.1;9.3]	7.1 [7.0;7.3]	7.8 [7.7;7.9]	8.4 [8.3;8.6]
60–69 years	7.3 [7.1;7.4]	7.9 [7.8;8.1]	8.6 [8.4;8.7]	6.5 [6.3;6.7]	7.1 [7.0;7.3]	7.8 [7.6;8.0]
70+ years	6.7 [6.4;7.0]	7.4 [7.1;7.6]	8.0 [7.7;8.3]	5.9 [5.7;6.2]	6.6 [6.3;6.9]	7.3 [6.9;7.6]
Trial 3						
Age 45–59 years	9.4 [9.3;9.6]	10.1 [10.0;10.2]	10.8 [10.7;11.0]	8.6 [8.4;8.7]	9.3 [9.2;9.4]	10.0 [9.8;10.2]
60–69 years	8.7 [8.5;8.9]	9.4 [9.3;9.6]	10.1 [9.9;10.3]	7.9 [7.7;8.0]	8.6 [8.4;8.7]	9.3 [9.1;9.5]
70+ years	8.1 [7.8;8.4]	8.8 [8.5;9.1]	9.5 [9.2;9.8]	7.2 [7.0;7.5]	7.9 [7.6;8.2]	8.6 [8.3;9.0]
Sum of trials						
Age 45–59 years	22.4 [22.0;22.7]	24.2 [23.9;24.4]	26.0 [25.7;26.3]	20.3 [20.0;20.7]	22.1 [21.8;22.4]	23.9 [23.5;24.3]
60–69 years	20.6 [20.2;21.0]	22.4 [22.0;22.8]	24.2 [23.8;24.6]	18.6 [18.1;19.0]	20.3 [20.0;20.7]	22.1 [21.7;22.6]
70+ years	19.2 [18.5;19.9]	21.0 [20.3;21.7]	22.8 [22.0;23.6]	17.2 [16.5;17.8]	19.0 [18.3;19.6]	20.8 [20.0;21.5]

(Continues)

TABLE 4 (Continued)

PANEL B	Sex					
	Female			Male		
	Education					
	<12 years	12 years	>12 years	<12 years	12 years	>12 years
Recall						
Age 45–59 years	8.2 [8.0;8.3]	8.9 [8.8;9.0]	9.7 [9.5;9.8]	7.2 [7.1;7.4]	8.0 [7.8;8.1]	8.7 [8.5;8.9]
60–69 years	7.3 [7.1;7.5]	8.0 [7.8;8.2]	8.8 [8.6;9.0]	6.3 [6.1;6.5]	7.1 [6.9;7.3]	7.8 [7.6;8.0]
70+ years	6.7 [6.3;7.0]	7.4 [7.1;7.8]	8.2 [7.8;8.6]	5.7 [5.4;6.1]	6.5 [6.1;6.8]	7.2 [6.8;7.6]

Abbreviation: TIA, transient ischemic attack.
Note: Numbers in brackets "[]" represent confidence intervals.

early preclinical stages of ADRD. Thus, the present results provide a step toward filling the critical need for appropriate normative data to advance studies of Hispanic/Latino cognitive aging, and a step toward generating better cognitive assessment tools for Hispanics/Latinos facing ADRD health disparities.[10] Further, we created a free and easy-to-use dashboard (https://solincalab.shinyapps.io/B-SEVLT_Norm_Calculator/)[27] to facilitate the application of our findings by clinical neuropsychologists and researchers.

Similar to previous findings from HCHS/SOL, Hispanic/Latino background groups differed in learning and memory after controlling for demographic factors such as age, sex, and education. Differences by Hispanic/Latino background remained when analyses were restricted to cognitively healthy individuals, highlighting the importance of taking background group into account when developing normative scores. Previous work suggested similar relationships between age and education with learning and memory across various Latin American countries but did not include individuals residing outside of their country of birth.[20] In contrast, our sample contained Hispanics/Latinos residing in the United States who varied widely in country of birth. Taking Hispanic/Latino background into account may improve accuracy of learning and memory measurements and avoids unwarranted generalizations based on aggregated Hispanic/Latino backgrounds.

Consistent with previous literature, older age was related to poorer learning and memory performance.[20,30,31] In our study, the average age for each Hispanic/Latino background group ranged from 55 to 58 years. Middle age is a critical period for development of preclinical ADRD, and research has shown that US Hispanics/Latinos may show symptoms of AD at a younger age than non-Hispanic/Latino Whites.[32,33] We also found that increased education was associated with better verbal learning and memory.[6,18,19] Our study increases the balance in sample size between low- and high-education groups with education spanning 0 to 22 years with an average ranging from 10 to 12 years in each background group. In previous studies, average educational attainment was typically 10 years and lower.[6,19] Hispanics/Latinos in the United States are becoming more educated each year; therefore, it is crucial to derive normative scores from samples that have a wide range of educational attainment.[34] Future research should investigate whether quality of education measured by educational experience (e.g., country of educational attainment, rural vs. urban) or literacy[35–37] differentially impact learning and memory among diverse Hispanics/Latinos.

Our results indicated that there was a female advantage on the B-SEVLT. Other research has also shown a female advantage on verbal learning and memory tests in Black and predominately White samples.[30,31,38] In contrast, research pertaining to Hispanics/Latinos residing in Latin America did not consistently find sex to be associated with verbal learning and memory performance.[20] A study of Mexican Americans did not find sex associations with verbal learning and memory,[6] but follow-up analysis indicated potentially different age-related declines in performance between men and women.[18] Although there have been inconsistencies, results from the present study and previous studies in this cohort[23,29] suggest that sex should be taken into account when assessing verbal learning and memory.

Consistent with research on the original SEVLT, which focused on US participants of Mexican background,[21,22] language preference for testing was not related to learning and memory performance in the present study. Furthermore, language use (i.e., thinking and socializing patterns) was not associated with verbal learning and memory performance. Research has shown that when participants are tested in their preferred language, there are no significant differences between monolingual Spanish or English speakers on verbal learning and memory assessments.[39–41] However, bilingualism (balanced vs. unbalanced) may influence learning and memory performance.[29,39,41] Future research should investigate whether objective data on degree of bilingualism predicts B-SEVLT performance to a greater degree than self-reported measures. A strength of the B-SEVLT is that it does not penalize participants who switch between English and Spanish regardless of their preferred language of testing administration. Allowing participants to answer in either language might reduce cognitive interference from competing languages.[42]

Given the novel nature of these results, future work should examine potential contributors to learning and memory differences among the various Hispanic/Latino backgrounds. Cardiovascular disease risk factors (e.g., type 2 diabetes mellitus, stroke, hypertension) vary between Hispanic/Latino backgrounds,[43] may impact learning and memory,[44,45] and have been associated with different types of ADRD.[46,47] Additionally, investigation into potential mediators/moderators (e.g., age, education, language preference, sex, cardiovascular disease risk) of

learning and memory performance and its decline between and within Hispanic/Latino background groups is warranted. Likewise, potential sociodemographic factors (e.g., quality of education, socioeconomic status, rural vs. urban educational setting) not examined in the current study are a crucial area for future investigation.

Our study has several limitations. First, the original SEVLT was developed with a sample of Hispanics/Latinos of Mexican background.[21] The SEVLT was based on the English language frequency prototypicality norms, and previous work with the SEVLT suggests similar measurement properties in English and Spanish. Following principles of item-response theory, the goal was to include common (easier) and less common (more difficult) words.[21,48] It is possible that the SEVLT may have different measurement properties for different Hispanic/Latino heritages due to sociodemographic, cultural, and/or regional factors. The present sample was broader than the initial SEVLT sample, but was still limited to Hispanics/Latinos from four regions in the United States. Therefore, a Pan-American panel of Latinos reviewed the word lists for commonality between Latino heritages, which led to the B-SEVLT items herein. Nevertheless, other factors may be associated with familiarity and imaginability of a given word, and, in turn, impact test performance. To begin to address this limitation, we provided normative data by Hispanic/Latino background, which varies by region. More broadly, cultural factors such as degree of acculturation may be associated with neurocognitive performance.[49,50] In the future, an item analysis may help identify specific test items that are biased toward Hispanics/Latinos of specific backgrounds, acculturation status, or other key cultural predictors of health. Most existing normative data on US Latinos is limited to specific regions of the country, especially the Southwest, and our study includes the largest and most diverse sample of middle-aged and older Hispanics/Latinos to date, maximizing the generalizability of our results.[9,24]

Second, the brief cognitive screener (i.e., the SIS) has not been validated in US Hispanics/Latinos. Therefore, our "low cognitive status" cut-off was determined as scoring below the 16th percentile relative to the overall sample. Third, stroke/TIA history was based on self-report. To ascertain precise CN and stroke/TIA diagnoses, future studies may collect neuroimaging data in addition to neuropsychological assessment and consider factors such as substance use history or diagnosis of a serious psychiatric, developmental, or neurological condition. The inclusion of individuals who suffer from severe substance use, or psychiatric or neurological conditions in normative data may affect average scores. Specialized normative datasets may be more appropriate for gauging cognition in these populations.

5 | CONCLUSION

To our knowledge, this is the first study to provide extensive normative data for a verbal episodic learning and memory test based on a representative sample of US Hispanics/Latinos. In accordance with the 2019 ADRD Summit's priority to reduce health disparities in ADRD, we developed the B-SEVLT and these normative data to be an easily accessible tool that clinicians and researchers can use to assess learning and memory in Hispanics/Latinos, particularly those in an age range of susceptibility to preclinical, prodromal, and early ADRD.[10] As when using any normative data, we caution clinicians and researchers to not base impressions on single test scores alone. Rather, we encourage the consideration of other relevant cultural factors (i.e., bilingualism, acculturation) that were beyond the scope of the present study.

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CONFLICTS OF INTEREST

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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