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Featured Article

The cross-sectional association of cognitive stimulation factors and cognitive function among Latino adults in Hispanic Community Health Study/Study of Latinos (HCHS/SOL)

Priscilla M. Vásquez[a,**], Wassim Tarraf[b], Adit Doza[b], Maria J. Marquine[c], Krista M. Perreira[d], Neil Schneiderman[e], Donglin Zeng[f], Jianwen Cai[f], Carmen R. Isasi[g], Martha L. Daviglus[h], Hector M. González[a,*]

[a]Department of Neuroscience, University of California San Diego, La Jolla, CA, USA
[b]Department of Healthcare Sciences & Institute of Gerontology, Wayne State University, Detroit, MI, USA
[c]Department of Psychiatry, University of California San Diego, La Jolla, CA, USA
[d]Department of Biostatistics, University of North Carolina Gillings School of Global Public Health, Chapel Hill, NC, USA
[e]Department of Psychology, University of Miami, Coral Gables, FL, USA
[f]Department of Biostatistics, University of North Carolina, Chapel Hill, NC, USA
[g]Department of Epidemiology and Population Health, Albert Einstein College of Medicine, Bronx, NY, USA
[h]College of Medicine, Institute for Minority Health Research, University of Illinois at Chicago, Chicago, IL, USA

Abstract

Introduction: Higher cognitive stimulation (CS) is associated with improved cognition. Sources of CS among Hispanics/Latinos are understudied.

Methods: In the Hispanic Community Health Study/Study of Latinos 2008 to 2011 (n = 9438), we used finite mixture models to generate latent CS profiles, and multivariate linear regressions to examine associations with cognition in Hispanic/Latino adults (45–74 years). CS included education, occupation, social network, and acculturation. Cognitive measures included the Six-Item Screener, Brief-Spanish English Verbal Learning Test Sum and Recall, Controlled Oral Word Association Test, Digit Symbol Substitution, and Global Cognition.

Results: Two CS profiles emerged, and were labeled "typical" and "enhanced." The enhanced CS profile (22%) had more family connections, bicultural engagements, skilled/professional occupations, education, and higher cognitive scores.

Discussion: An enhanced CS profile emerged from contextual and culturally relevant factors, and was associated with higher cognitive scores across all measures. This provides initial evidence on how factors coalesce to shape cognitive protection in Hispanics/Latinos.

Keywords: Cognitive stimulation; Cognition; Hispanic; Latino; Epidemiology; Social network; Biculturalism

1. Introduction

The Hispanic/Latino population in the United States is arguably at increased risk for cognitive decline and Alzheimer's disease and related dementias (ADRD) [1]. It is believed that symptoms of Alzheimer's disease may begin 4 to 7 years earlier for Hispanic/Latino adults compared with non-Hispanic/Latino adults [2,3]. Current research shows that

*Corresponding author. Tel.: (858) 534-5361; Fax: (858) 246-2077.
**Corresponding author. Tel.: (858) 246-1038; Fax: (858) 246-2077.
E-mail address: pvasquezguevara@ucsd.edu (P.M.V.), hectorgonzalez@ucsd.edu (H.M.G.)

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older Hispanic/Latino adults have fewer resources for cognitively stimulating activities and lower frequency of engagement in such activities [4]. Evidence suggests that increased involvement in cognitively stimulating activities can be protective against cognitive decline and ADRD [5–7]. Cognitive stimulation (CS), however, has been measured in different and sometimes inconsistent ways.

Under most definitions, the core concept of CS involves engagement in activities seeking or processing information [8,9]. Previous research has focused on educational or leisure-time pursuits such as socializing, educational, and cultural activities to define cognitively stimulating activities [10,11]. Interventions to support CS show promise in maintaining cognitive function, but these intervention studies are limited to predominantly highly educated and homogenous non-Hispanic/Latino white samples [5]. The changing demographic realities in the United States emphasize the need to expand the conceptualization and definition of CS to capture aspects that are most relevant to under-represented groups [9].

Identification of culturally relevant protective factors in the Hispanic/Latino population is warranted, and we posit that there is an opportunity to examine a construct of CS via occupation, familial social networks, and/or bicultural engagements in combination with traditional factors (i.e., education). Although these factors have been examined individually, they can co-occur throughout the lifecourse. Thus, we are interested in investigating how these factors interact to protect cognitive function. Briefly, previous work indicates that occupational characteristics, such as engaging in self-directed work and higher work control, were associated with slower cognitive decline [10]. Higher educational attainment was associated with higher cognitive performance among Hispanics/Latinos [12]. In addition, we seek to explore the role of biculturalism given the mixed evidence on the protective effects of bilingualism among Hispanic/Latino adults [13,14]. Finally, social engagements and social networks have been associated with protection of cognition and this may be especially relevant to Hispanics/Latinos in the United States [15,16].

In this study, using the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), we propose to use a novel classification of CS to generate profiles associated with higher cognitive function among Hispanics/Latinos. This study expands the definition of CS to incorporate contextual and culturally relevant factors thereby revealing potential avenues to explore these concepts longitudinally among Hispanics/Latinos. This study may also point to potential areas to intervene on to support healthy cognitive aging among diverse, middle-aged, and older Hispanic/Latino adults.

2. Methods

2.1. Data

We examined cross-sectional data from the HCHS/SOL (2008–2011), a community-based cohort study (N = 16,415) assessing health risks and protective factors for chronic conditions among a diverse sample of Hispanic/Latino adults in the United States. HCHS/SOL targeted four metropolitan areas with high densities of diverse Hispanics/Latinos (Bronx, NY; Chicago, IL; Miami, FL; and San Diego, CA). Self-identified Hispanic/Latino adults of Central American, Cuban, Dominican, Mexican, Puerto Rican, and South American backgrounds aged 18 to 74 years enrolled in HCHS/SOL and persons aged 45 to 74 years were oversampled. Standardized cognitive assessments were administered to participants aged 45 years and older. Baseline examinations were conducted by trained bicultural/bilingual staff in the preferred language (English/Spanish) of the participant. This study was approved by the institutional review boards at each participating institution. Informed consent was obtained for all participants at the beginning of baseline examination; detailed information on study design, sampling, and implementation has been reported previously [17,18].

2.2. Analytic sample

We focused on participants with cognitive assessments in HCHS/SOL (N = 9623). We excluded participants with missing data for potential confounders described subsequently (N = 185) leaving a final analytic sample of N = 9438.

2.3. Dependent variables: Cognitive function

The cognitive battery included (1) the Six-Item Screener (SIS), (2) the Brief-Spanish English Verbal Learning Test (B-SEVLT) Sum (i.e., sum of three learning trials), (3) the B-SEVLT Recall, (4) the Controlled Oral Word Association (or Word Fluency; WF), and (5) the Digit Symbol Substitution (DSS) Test [12]. The B-SEVLT was developed for Spanish and English speakers, and the WF used only letters F and A to avoid language bias with the letter S. All cognitive measures (except B-SVELT) were translated (English to Spanish) and back translated (Spanish to English). We created a global cognition score derived from confirmatory factor analyses using the five cognitive measures, freeing all factor loadings and setting the mean of the latent factor to 0 and the standard deviation to 1. In addition to the derived global cognitive score we modeled the B-SEVLT Sum, B-SEVLT Recall, WF, and DSS independently to examine possible differential associations between CS and specific domains of cognitive function. All outcomes were z-scored to facilitate the comparisons of effects across the estimated models, and the z-score was based on the mean and standard deviation of participants aged 45 years or older with cognitive measures. More detailed information on the HCHS/SOL cognitive outcomes has been reported [12].

2.4. Independent variable: CS

A CS variable was derived using latent class analysis with measures of education, occupation, acculturation, and social

network. We selected these four variables because they have been independently associated with higher cognitive function in previous research [10,12,14–16].

2.4.1. Contextual factors

Education was self-reported as less than high school/General Education Development certificate (GED), high school/GED, or greater than high school/GED. For occupation, participants were asked "*What is the type of job that you have held the longest?*" Responses included *non-skilled* (construction, yard, or migrant laborers); *service* (housekeepers, cooks, waiters, doorkeepers, hairdressers, counter salespersons, launderers, or child care workers); *skilled* (foremen or craftsmen); *professional* (doctors, professors, lawyers, architects, engineers, midwifes, nurses, teachers, editors, or photographers), administrators/executives/managers (working proprietors, government officials, section chiefs, department/bureau directors, administrative cadre, or village leaders), or office staff (secretaries or office helpers). Finally, the *other* category included farmers, fishermen, hunters, army officers, police officers, drivers, athletes, actors, musicians, or other. Participants who were retired or not currently employed were still asked the question on longest held occupation with the listed possible options.

2.4.2. Culturally relevant factors

Acculturation was assessed using the Short Acculturation Scale for Hispanics, and we also used a measure from the Multi-Ethnic Study of Atherosclerosis, which asked for the participants' place of birth and years of residence in the United States. We incorporated place of birth to include possible differences in experience among participants. The Short Acculturation Scale for Hispanics has two subscores, one capturing social acculturation and the other language acculturation. We were particularly interested in bicultural engagements, which we operationalized as engaging in activities in both English and Spanish language. This serves as a proxy for cognitive activity stimulated by engaging in multiple languages. For social acculturation, we measured the extent of participants' self-reported social interactions with Hispanics/Latinos and non-Hispanics/Latinos. This included close friends, social gatherings, persons visited, and preference for children's friends on a five-point Likert scale, where "1" corresponded to all Hispanic/Latino and "5" corresponded to all non-Hispanic/Latino. The language acculturation subscore captures the use of Spanish and English languages in familial and social engagements, preferences for media (e.g., radio, TV), reading, speaking, and thinking on a five-point Likert scale, where 1 corresponded to only Spanish and 5 corresponded to only English. The Multi-Ethnic Study of Atherosclerosis measure captures place of birth and years of residence in the United States. Years of residency in the United States was categorized as 20 years and more, 10 to 20 years, or less than 10 years.

Familial social network was assessed by three indices capturing the amount of contact with (1) parents, (2) in-laws, and (3) other relatives. The questions include "*Do you see or talk on the phone to either of your parents at least once every 2 weeks*?" "*Do you see or talk on the phone to either of your in-laws (or partner's parents) at least once every 2 weeks*?" "*How many other relatives (other than your spouse, parents, and children) do you feel close to*?" The parental and in-laws network variables were recoded such that individuals without parents or contact with parents were coded as zero, contact with mother or father was coded as 1, and contact with both mother and father was coded as 2. The relatives network variable is a count of number of individuals and ranges from 0 to $\geq$7. This is the original coding used for HCHS/SOL. We recognize that participants may be in contact with family members via text messaging or e-mail, and these modes of communication are not specifically captured by this measure.

2.5. Potential confounders

Analyses were adjusted for six potential confounders known to influence cognitive function. Sociodemographic factors included were (1) age in years and age squared [19], (2) sex, and (3) Hispanic/Latino background. Mental health factors included (1) depressive symptoms (Center for Epidemiologic Studies Depression Scale-10) and (2) anxiety symptoms (State-Trait Anxiety Inventory). Finally, we adjusted for study site (San Diego, CA; Chicago, IL; Bronx, NY; Miami, FL) to account for possible differences across sites.

2.6. Analyses

We used finite mixture modeling to derive latent profiles of CS and examined associations with cognitive function. Latent profile analyses followed standard modeling strategies [20–22] previously used in HCHS/SOL [23]. Latent profile techniques accommodated the complex survey design of HCHS/SOL [24–26]. Supplementary Fig. 1 depicts the examined association between latent CS and cognition function. Optimal fit and determination of the number of satisfactory profiles followed an iterative process (increasing the number of classes incrementally until optimal fit is achieved) and used standard fit assessment criteria [27,28]. We examined latent profile models with up to seven classes and assessed model fit statistics to determine the number of latent profiles. In Appendix 1, we provide a brief description of the solutions, in Supplementary Table 1, we provide results for up to four class solutions, and the model fit statistics. In Supplementary Table 2, we provide the parameter estimates from the optimal latent profile solution.

Across all tested latent profiles education and occupation were treated as categorical indicators and all other variables as continuous. In sensitivity analyses, we re-estimated the models treating the parental and in-laws network indicators as well as education as ordinal measures. The best-fit solution remained unchanged, and the overlap in the estimated class memberships was nearly identical.

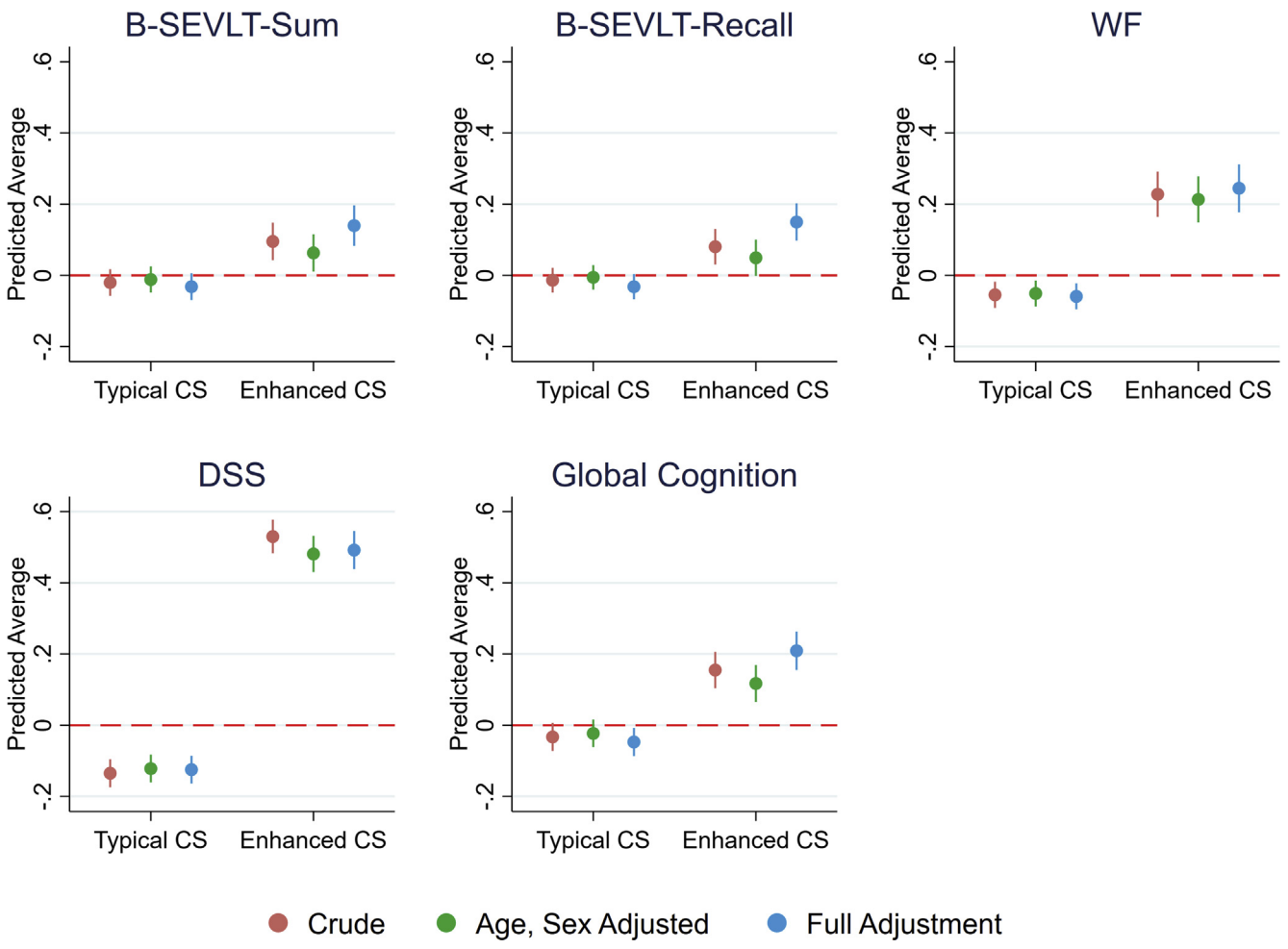

Fig. 1. Latent profile model of cognitive stimulation and cognition. Abbreviations: CS, cognitive stimulation; B-SEVLT, Brief-Spanish English Verbal Learning Test; DSS, Digit Symbol Substitution; WF, Word Fluency.

Several model fit statistics were examined including (1) entropy, (2) Akaike information criterion, (3) Bayesian information criterion, (4) sample-size adjusted Bayesian information criterion, (5) Vuong-Lo-Mendell-Rubin, and (6) Lo-Mendell-Rubin Adjusted Likelihood Ratio Test. Final determination of the number of classifications was done ensuring that the chosen model represented meaningfully distinct profiles. Individual classification into the derived groups was determined based on their highest posterior probability. We used the generated classification indicator in all subsequent regression analyses as the primary predictor. Figs. 1 and 2 provide the marginal means and differences of marginal means, respectively, and the differences in marginal means are based on contrasts generated using analysis of variance style tests as implemented in Stata and compare estimated average outcome levels relative to a reference group [29,30].

We used multivariable linear regression models to examine the associations between the derived latent profiles and cognitive function for global cognition and the individual cognitive tests (1) B-SEVLT Sum, (2) B-SEVLT Recall, (3) WF, and (4) DSS. Beta coefficients and standard errors are reported for the associations between CS groups and cognition. In Fig. 2, we provide a graphical representation comparing average cognitive scores by the CS group for each cognitive measure. All analyses accounted for the

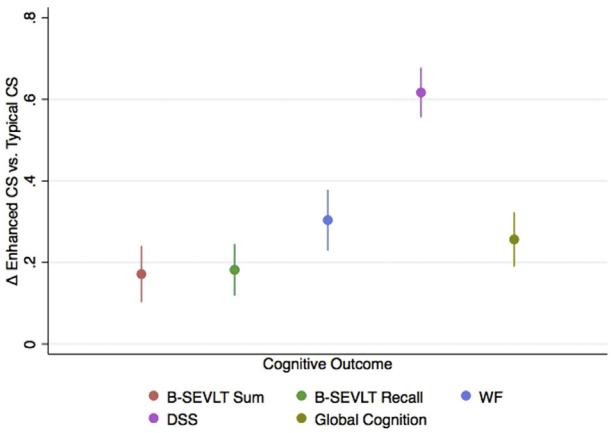

Fig. 2. Estimated marginal differences between typical and enhance CS groups. Abbreviations: CS, cognitive stimulation; B-SEVLT, Brief-Spanish English Verbal Learning Test; DSS, Digit Symbol Substitution; WF, Word Fluency.

Table 1
Descriptive statistics for Hispanic/Latino adults by cognitive stimulation profiles in the Hispanic Community Health Study/Study of Latinos

Study characteristics	Total sample mean (SE)/%	Cognitive stimulation mean (SE)/%	
		Typical	Enhanced
(Unweighted N = 9438)	100%	78% (N = 7361)	22% (N = 2076)
Age (y)	56.5 (0.1)	57.0 (0.2)	54.4 (0.3)
Female	54.6	56.1	43.9
Education			
<High school/GED	39.7	44.0	23.4
High school/GED	21.3	21.2	21.7
>High school/GED	38.9	34.7	54.9
Social Network Index			
Parents	0.56 (0.01)	0.53 (0.01)	0.64 (0.03)
In-laws	0.29 (0.01)	0.29 (0.01)	0.31 (0.02)
Relatives	3.88 (0.04)	3.90 (0.05)	3.77 (0.09)
Sociocultural			
Nativity	1.47 (0.03)	1.23 (0.03)	2.36 (0.02)
Social acculturation	2.15 (0.01)	1.99 (0.01)	2.73 (0.02)
Language acculturation	1.76 (0.03)	1.32 (0.01)	3.41 (0.03)
Longest held occupation			
Non-skilled	23.7	25.7	16.4
Service	15.4	17.3	8.2
Skilled	22.4	20.3	30.4
Professional	17.9	15.3	27.8
Other occupations	20.5	21.4	17.2
Depression symptoms	7.5 (0.1)	7.4 (0.1)	8.1 (0.3)
Anxiety symptoms	17.0 (0.1)	16.9 (0.1)	17.4 (0.3)

Abbreviations: GED, General Education Development certificate; SE, standard error.

complex design of the HCHS/SOL including selection probabilities, clustering, and stratification. Analyses were performed using Stata Statistical Software, Release 14 (StataCorp LP, College Station, TX), and MPLUS V8.

3. Results

3.1. Descriptive statistics

Overall, the average age in our study was 56.5 years old, 54.6% were female, and 39.7% had less than a high school diploma/GED (Table 1). On the basis of the model fit statistics, a two latent profile solution best fit the data (Supplementary Table 1), and we putatively designated the profiles as *typical* and *enhanced* CS based on the characteristics that emerged from data as described in Appendix 1. The descriptive statistics for each derived latent profile is presented in Table 1.

3.2. Associations between CS and cognitive measures

In crude models, compared with those in the typical CS, those in the enhanced CS group had higher scores across all five cognitive measures. In adjusted models, adjustment by age, sex, and potential confounders attenuated the associations; however, they remained statistically significant across all cognitive measures (Table 2). The beta-coeffients (β) and standard errors (SE) for the age- and sex-adjusted results are as follows: global cognition β(SE) = 0.14(0.03), B-SEVLT Sum β(SE) = 0.07(0.03), B-SEVLT Recall β(SE) = 0.05(0.03), WF β(SE) = 0.26(0.04), and DSS β(SE) = 0.60(0.03). Full-adjusted results are as follow: global cognition β(SE) = 0.26(0.03), B-SEVLT Sum β(SE) = 0.17(0.04), B-SEVLT Recall β(SE) = 0.18(0.03), WF β(SE) = 0.30(0.04), and DSS β(SE) = 0.62(0.03) all with $P < .001$. Fig. 1 shows the marginal mean estimates for each cognitive measure for each latent profile. Overall, the enhanced CS group scored consistently higher on global cognitive function and individual cognitive measures, especially in DSS and WF compared with the typical CS group. Fig. 2 includes the estimated marginal differences and 95% confidence intervals between the typical CS and enhanced CS groups derived from the fully adjusted regression models. The difference between typical and enhanced CS was most pronounced with the DSS.

4. Discussion

In this study, we found that higher CS was associated with higher cognitive function. We observed evidence to support two groups designated as typical and enhanced CS. Enhanced CS comprised individuals with more established family networks, had more bicultural engagements, had higher skilled occupations, higher education, and generally higher socioeconomic status. The enhanced CS group had higher scores across all cognitive measures examined, especially with DSS, which is a measure of executive function. Our definition of CS incorporates contextual and culturally relevant factors for Hispanic/Latino adults that collectively are suggestive of cognitive protection. Although the present study is cross-sectional, the factors included represent

Table 2
Association between cognitive stimulation and cognitive function

CS profile	Cognitive measures: Global cognition β(SE)			B-SEVLT Sum β(SE)			B-SEVLT Recall β(SE)			WF β(SE)			DSS β(SE)		
	Crude	Age, sex	Full	Crude	Age, sex	Full	Crude	Age, sex	Full	Crude	Age, sex	Full	Crude	Age, sex	Full
Enhanced CS	0.19^{*}	0.14^{*}	0.26^{*}	0.12^{*}	$0.07^{\dagger}$	0.17^{*}	$0.09^{\ddagger}$	0.05	0.18^{*}	0.28^{*}	0.26^{*}	0.30^{*}	0.66^{*}	0.60^{*}	0.62^{*}
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.03)

NOTE. All cognitive measures were standardized. Crude: unadjusted linear regression model. Age, sex: adjusted for age and sex. Full: adjusted for age, age squared, sex, Hispanic/Latino background, depressive symptoms, anxiety symptoms, and study site.
Abbreviations: CS, cognitive stimulation; B-SEVLT, Brief-Spanish English Verbal Learning Test; DSS, Digit Symbol Substitution; WF, Word Fluency.
$^{*}P < .001$.
$^{\dagger}P < .05$.
$^{\ddagger}P < .01$.

everyday life and as such may still reflect a comprehensive view of CS among middle-age and older Hispanics/Latinos.

Our construct of CS incorporates culturally relevant factors to reveal additional protective factors among Hispanic/Latino adults. The premise of this approach was to provide actionable information for intervening among Hispanics/Latinos. Previous work has shown independent associations between cognition and social networks [31], occupation [32,33], and education [34] as well as mixed evidence for biculturalism [13,35,36]. However, given the complexity of cognitive function and the level of heterogeneities in cognitive performance and disease in the population, it is unlikely that these factors work uniformly and in isolation in shaping cognitive health. Our study provides initial evidence to support examining multiple factors in combination, how they coalesce, and finally their collective association with higher cognitive performance. We observed that latent profiles, which include familial social networks, bicultural engagements, occupation, and education, may offer cognitive protection, identify those at high risk, and also viable points of intervention.

Our findings provide initial evidence to multimodal interventions that may consider including the components examined in the present study. First, we examined familial social networks, which present opportunities for family-based interventions addressing cognitive health, as well as social networks more broadly. To our knowledge, there are no family-based interventions that focus on cognitive health, but there are family-based interventions that focus on health outcomes [37]. There is evidence on the benefits of stronger social networks and cognitive function using neuropsychological tests [38] and neuroimaging data [39]. Although educational attainment is considered to be static, there is an opportunity for adult educational programming and continued support for health educational opportunities. This lends itself to the notion of supporting lifelong learners, or the importance of learning opportunities throughout the lifecourse to maintain cognitive health. There is an added opportunity for engagement in bicultural activities, which foster the use of Spanish and English languages. Engagement in two and potentially more cultures may align with the notion of continued learning and supporting cognitively stimulating activities. For occupations, there has been increased interest and development in implementing workplace wellness programs [40] as well as consideration of occupation in relation to cognition [41]. Although occupations are also not modifiable, there is an opportunity for trainings to be included with a focus on cognitive health. Future programs interested in addressing cognitive health can take a multimodal approach or can incorporate multiple aspects simultaneously that have been linked to cognitive function.

Finally, the differences between typical and enhanced CS were more pronounced with WF and DSS, which respectively measure executive functioning, and processing speed as well as visuospatial ability. Executive functioning, processing speed, and visuospatial ability are hallmarks of

ADRD [42]. The implications of our findings are limited by the cross-sectional design of our study. However, there is potential for future work examining longitudinal associations. For example, processing speed and executive function have been shown to be more sensitive to cognitive decline among Hispanic/Latino adults compared with Whites [43,44]. The present study provides initial evidence on factors associated with enhanced executive functioning and processing speed, but further investigation is warranted.

This study has several strengths. We provide a novel approach to model CS via culturally relevant factors that include biculturalism, and familial networks as well as contextual factors education, and occupation. Collectively, these factors account for a larger proportion of participants' everyday interactions and circumstances. Second, this study used a large, representative, and well-characterized cohort of diverse middle-aged and older Hispanic/Latino adults. Third, use of latent profiles allowed us to examine how the proxy measures for CS cluster to reveal the different groupings among the Hispanic/Latino population based on the factors examined and their relationships to cognition. A small proportion of Hispanic/Latino adults in our study satisfied classification criteria for the enhanced CS profile compared with typical CS. As such, our results suggest potential for maintaining cognitive health among Hispanic/Latino adults.

This study has several limitations. First, the cross-sectional design allows for the possibility of reverse causation where those who have better cognition might be able to engage in more cognitively stimulating contexts. A second limitation was the lack of measurements specific to leisure-time cognitively stimulating activity (i.e., reading, completing puzzles, or attending plays) in this cohort. Third, we used measures of acculturation to examine biculturalism, such that other aspects of biculturalism are not captured in this study. Fourth, although we accounted for several cognitive tests representing multiple domains of cognition, these tests may not be as sensitive to our relatively young cohort. Finally, additional potential confounders such as cardiovascular disease risk factors and sleep duration along with other factors known to influence cognitive function were not examined as they are outside the scope of this study. These limitations merit further investigation.

In conclusion, we operationalized CS as a combination of socioeconomic, familial networks, and acculturation factors. The enhanced CS group was associated with better cognitive function across all measures examined. Our findings suggest multiple factors may coalesce to shape cognitive function in diverse middle-aged and older Hispanic/Latino adults.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.trci.2019.07.006.

RESEARCH IN CONTEXT

1. Systematic review: The authors searched peer-reviewed articles using PubMed and the affiliated University Library. Cognitive stimulation (CS) is associated with improved cognitive function, but current evidence may be missing important aspects of CS relevant to Hispanic/Latino adults.
2. Interpretation: We incorporated education, occupation, social network, and acculturation to capture CS among middle-age and older Hispanic/Latino adults. We observed an "enhanced" CS profile, which was associated with higher cognitive scores across all measures.
3. Future directions: CS is an area of study that warrants further investigation. Inclusion of contextual and culturally relevant factors for under-represented groups (e.g., Hispanic/Latino adults) can aid in expanding and strengthening current evidence showing the benefits of CS on cognition. A comprehensive examination of CS factors may provide insight on how multiple factors coalesce to shape cognitive protection.

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