Research Article

Emotional health and its association with neurocognition in Hispanic and non-Hispanic White people with HIV

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Abstract

Objective: Emotional functioning is linked to HIV-associated neurocognitive impairment, yet research on this association among diverse people with HIV (PWH) is scant. We examined emotional health and its association with neurocognition in Hispanic and White PWH. **Methods:** Participants included 107 Hispanic (41% primarily Spanish-speakers; 80% Mexican heritage/origin) and 216 White PWH (Overall age: $M = 53.62$, $SD = 12.19$; 86% male; 63% AIDS; 92% on antiretroviral therapy). Emotional health was assessed via the National Institute of Health Toolbox (NIHTB)-Emotion Battery, which yields T-scores for three factor-based summary scores (negative affect, social satisfaction, and psychological well-being) and 13 individual component scales. Neurocognition was measured via demographically adjusted fluid cognition T-scores from the NIHTB-cognition battery. **Results:** 27%–39% of the sample had problematic socioemotional summary scores. Hispanic PWH showed less loneliness, better social satisfaction, higher meaning and purpose, and better psychological well-being than Whites ($ps < .05$). Within Hispanics, Spanish-speakers showed better meaning and purpose, higher psychological well-being summary score, less anger hostility, but greater fear affect than English speakers. Only in Whites, worse negative affect (fear affect, perceived stress, and sadness) was associated with worse neurocognition ($p < .05$); and in both groups, worse social satisfaction (emotional support, friendship, and perceived rejection) was linked with worse neurocognition ($p < .05$). **Conclusion:** Adverse emotional health is common among PWH, with subgroups of Hispanics showing relative strengths in some domains. Aspects of emotional health differentially relate to neuro-cognition among PWH and cross-culturally. Understanding these varying associations is an important step towards the development of culturally relevant interventions that promote neurocognitive health among Hispanic PWH.

Keywords: emotional health; cognition; negative affect; social satisfaction; Hispanics; HIV

(Received 19 January 2022; final revision 25 January 2023; accepted 17 March 2023; First Published online 20 April 2023)

Introduction

People with HIV (PWH) are at increased risk for neurocognitive impairment (NCI) (Clifford & Ances, 2013; Heaton et al., 2010), with HIV-associated neurocognitive disorders (HAND) evident in up to half of PWH (Heaton et al., 2010; Heaton et al., 2014; Saloner & Cysique, 2017). Hispanics/Latinos/as/e/x, hereafter Hispanics, are the largest ethnic minority in the USA and at three-fold risk for HIV infection compared to non-Hispanic Whites, hereafter Whites (HIV Surveillance Report, 2019). Hispanic PWH in the USA have worse disease outcomes including higher rates of acquired immunodeficiency syndrome (AIDS) and mortality compared to White PWH (McGinnis et al., 2003;

Mindt et al., 2014). While Hispanics are at increased risk for NCI and neurocognitive decline, factors explaining this disparity are not clear (Marquine et al., 2018; Mindt et al., 2014; Watson et al., 2022).

Emotional disorders characterized by negative affect such as depression and anxiety are prevalent in PWH. Rates of depression and anxiety are higher in PWH than the general population at approximately 20% and 50%, respectively (Ciesla & Roberts, 2001; Fazeli et al., 2011). Similarly, PWH report higher rates of loneliness, which may contribute to high rates of mood and substance use challenges (Edelman et al., 2014; Greene et al., 2018; Grov et al., 2010; Heywood & Lyons, 2016) and have critical implications for the quality of life and disease progression of PWH.

Depressive symptoms have been associated with worse medication adherence, which may lead to lower CD4 count and higher HIV plasma viral load and contribute to cognitive impairment (Heaton et al., 2010; Scott et al., 2018).

Some literature indicates that Hispanics are at increased risk for adverse emotional health (i.e, higher rates of depression and anxiety) in comparison to Whites (Hernandez et al., 2005; Pratt & Brody, 2014), while other studies show Hispanic ethnicity is associated with positive emotional health including less loneliness (Gallegos & Segrin, 2021), better psychological well-being (Losada et al., 2006) and life satisfaction (Calvo et al., 2017; Marquine et al., 2015). Yet, other research indicates comparable levels between groups (Breslau et al., 2006; Woodward et al., 2012). Using the NIH Toolbox Emotion Battery (NIHTB-EB), studies found that Hispanics reported better social satisfaction (emotional support, friendship, and loneliness) and psychological well-being (life satisfaction, meaning and purpose) than Whites (Zahodne et al., 2021; Zahodne et al., 2018). Yet, comprehensive studies evaluating ethnic differences in emotional health among diverse PWH are lacking.

Social and emotional health has important implications for neurocognition. Worse depressive symptoms, anxiety, discrimination, acculturative and perceived stress have been linked to worse neurocognition in Hispanics (Camacho et al., 2018; Estrella et al., 2021; Marquine et al., 2022; Muñoz et al., 2019). Other studies show lower loneliness, greater purpose of life, social, and familial support are linked with better neurocognitive and mental health outcomes in Hispanics (Chavez-Korell et al., 2013; Estrella et al., 2021; Mulvaney-Day et al., 2007; Valdivieso-Mora et al., 2016). A cross-sectional study among older community-dwelling adults of diverse backgrounds utilizing the NIHTB Emotion and Cognition batteries showed differential ethnic associations between emotion and cognition (Zahodne et al., 2018). In this study, greater emotional support and higher purpose in life were associated with worse working memory in Hispanics, but not among non-Hispanics (Zahodne et al., 2018). Greater friendship was associated with better working memory in Whites, but this association was non-significant among Hispanics. Yet, a similar longitudinal study using the NIHTB revealed that higher friendship was associated with less neurocognitive decline across Hispanics and Whites (Zahodne et al., 2021). In contrast to Zahodne's studies with healthy diverse older adults, our study including middle-aged adults with HIV might provide further insight into the effects of age and health status on emotional and neurocognitive health.

Emotional difficulties such as stress and trauma have also been associated with increased risk for HIV-associated neurocognitive impairment (Rubin et al., 2015; Watson et al., 2019). Relatedly, loneliness and social isolation in adults with and without HIV have been associated with worse neurocognition (Han et al., 2017; Kelly et al., 2017; Wilson et al., 2007). Yet, investigations of ethnic differences in emotional health among PWH, and the link between emotional health and neurocognition among Hispanic PWH are limited.

The current study aimed to (1) characterize and compare emotional health in Hispanic and White PWH and (2) investigate the associations between emotional health and neurocognition across Hispanic and White PWH utilizing the NIHTB Emotion and Cognition batteries. Considering the heterogeneity within the US Hispanic population, we also examined whether there were differences within Hispanics on our main outcomes of interest based on primary language (English/Spanish), which is closely

linked to other culturally relevant factors (e.g., acculturation, country of birth, years living in the USA). Increased understanding of emotional health and its link to neurocognition among diverse PWH might shed light on mechanisms of HIV-associated neurocognitive dysfunction that are most relevant for different cultural groups. This is an important initial step towards the development of culturally-relevant interventions that consider culture specific mechanisms of HIV-associatated neurocognitive dysfunction, and addressing neurocognitive disparities (Thomas et al., 2011).

Methods

Participants

Participants included 323 (107 Hispanic and 216 White) PWH recruited from the San Diego area and enrolled in observational cohort studies at the UCSD HIV Neurobehavioral Research Program (HNRP) from 2014 to 2020. Exclusion criteria for these cohort studies include history of head injury with loss of consciousness greater than 30 min or other severe neuromedical comorbidities that may affect cognitive functioning (i.e., stroke, epilepsy, opportunistic CNS infection). Participants who tested positive on urine toxicology or breathalyzer tests on the day of neuropsychological testing were rescheduled. Detailed descriptions of these studies can be found in prior reports (Doyle et al., 2013; Heaton, Franklin, et al., 2014). All data were obtained in compliance with the Helsinki Declaration and approved by the ethics committee of the UCSD Institutional Review Board. Participants demonstrated decisional capacity to consent, provided written informed consent, and were compensated for their participation. Inclusion criteria for present analyses were self-identifying as Hispanic or White, available National Institute of Health Toolbox Cognition Battery (NIHTB-CB) data, and at least two of the three National Institute of Health Toolbox Emotion Battery (NIHTB-EB) summary T-scores (e.g., negative affect, psychological well-being, and social satisfaction) and their component scales administered at the same visit. Data from the first visit that the NIHTB was administered were used for this cross-sectional study.

Materials and procedures

Participants completed comprehensive neurocognitive, neuromedical, and psychiatric assessments. Sociodemographic information (age, sex, years of education, sexual orientation, employment status) was ascertained via self-report. Language of test administration was determined based on participants self-reported fluency in English and Spanish, and language preference. Specifically, participants reported how well they spoke English and Spanish using a Likert-type scale (0 = not well to 3 = very well), and were tested in the language that they reported having greater fluency on. Participants reporting equal fluency in both languages were tested in their preferred language (Cherner et al., 2007; Mungas et al., 2004). Spanish-speaking participants were evaluated by trained English-Spanish bilingual and bicultural staff.

Neurocognitive assessment

The NIHTB-CB was used to assess neurocognition (Heaton, Akshoomoff, et al., 2014; Weintraub et al., 2013; Weintraub et al., 2014). One of the NIHTB-CB composite scores is Fluid Cognition, which measures attention, executive function, episodic memory, working memory, and processing speed. These cognitive

domains are most likely to be impacted by HAND (Akshoomoff et al., 2013; Heaton, Franklin, et al., 2014). The primary outcome of our analyses was demographically-adjusted Fluid Cognition T-scores that correct for age, gender, education, and ethnicity/race with different norms for English and Spanish-speakers (Casaletto et al., 2015; Casaletto et al., 2016).

Emotional health assessment

Emotional health was assessed using the NIHTB-EB (Salsman et al., 2013), comprised of 13 individual scales grouped into three summary scores based on prior confirmatory factor analyses: negative affect (i.e., anger affect, anger hostility, sadness, fear affect, and perceived stress), social satisfaction (i.e., friendship, emotional support, instrumental support, and reverse-coded loneliness and perceived rejection), and psychological well-being (i.e., meaning and purpose, life satisfaction, and positive affect) (Babakhanyan et al., 2018). Raw scores for each individual scale were converted to normalized T-scores reflecting an individual's emotional characteristic in relation to the average English or Spanish-speaker in the USA. T-scores for English-speakers are based on Census-weighed normative data, whereas T-scores for Spanish-speakers are based on sample-weighted norms (Babakhanyan et al., 2018). Main predictors were negative affect, social satisfaction, and psychological well-being summary T-scores. To aid in the clinical interpretation of emotional health summary T-scores, those beyond one SD in the direction of distress (i.e., negative affect T-scores > 60, psychological well-being T-scores < 40, and social satisfaction T-scores < 40) were categorized as "problematic" (Babakhanyan et al., 2018). Notable average T-scores that were at least 4 scores from the normative mean of 50 were identified as lower or higher emotional health than either census weighted or sample weighted normative sample. The 13 individual scales that comprise the summary scores were similarly evaluated.

Neuromedical assessment

Neuromedical assessments included a structured medical interview, neurological examination, blood draw, and urine sample collection. AIDS status, estimated years of HIV disease, antiretroviral therapy (ART) regimen, and months of exposure to ART were obtained via self-report. Laboratory measurements consisted of clinical chemistry panels, blood counts, rapid plasma reagin (screen for syphilis), Hepatitis-C (HCV) antibody, CD4+ T cells (flow cytometry), and urine toxicology. Procedures were performed at a Clinical Laboratory Improvement Amendments (CLIA)-certified, or CLIA-equivalent, laboratory. HIV disease diagnosis was confirmed by enzyme-linked immunosorbent assay with Western blot confirmation. HIV RNA levels in plasma were measured by reverse transcriptase polymerase chain reaction (Roche Amplicor, v. 1.5, lower limit of quantitation 50 copies/milliliter) to ascertain detectability of plasma HIV RNA.

Psychiatric and substance use assessments

Participants completed the Composite International Diagnostic Interview (Version 2.1) (Kessler et al., 1998; Wittchen 1994). Diagnoses for current (within past 12 months) and lifetime Major Depressive Disorder and Substance Use Disorders for alcohol, cannabis, opioids, methamphetamine, cocaine, sedatives, and hallucinogens were assigned based on the Diagnostic and Statistical Manual-Fourth Edition (DSM-IV).

Statistical analyses

Sample characteristics were examined for and met parametric assumptions. Differences in demographics, HIV disease and psychiatric characteristics, and Fluid Cognition T-scores were compared between Hispanics and Whites (and between primarily Spanish- or English-speaking Hispanics) using Chi^2 (or Fisher's exact) and independent sample t-tests as appropriate.

For our first aim, we compared NIHTB-EB summary and individual scale T-scores by ethnicity (and language group within Hispanics) via a series of independent sample t-tests. For summary and individual scale T-scores that differed by group, we conducted separate linear regression models, using ethnicity (or language group within Hispanics) as the predictor, adjusting for covariates (i.e., demographic, HIV, psychiatric, and substance use characteristics that significantly differed between groups at α < .10).

For our second aim, we ran three separate multivariable linear regression models examining the association between each of the three Emotion summary T-scores on Fluid Cognition T-scores by ethnicity. Each model included terms for (1) ethnicity; (2) the Emotion summary T-scores of interest; (3) the two-way interactive effects between these two variables; and (4) significant covariates (demographic, HIV, psychiatric, and substance use characteristics that differed between ethnicity and/or were univariably associated with Fluid Cognition at α < .10 among the overall sample). Variables and interaction terms that were not significant at α > .10 were removed and models rerun. Significant interaction effects were followed up with stratified models by ethnicity. For Emotion summary T-scores that showed a significant link with Fluid Cognition T-scores, we examined the association between the individual scales comprising the summary score and Fluid Cognition T-scores. We additionally examined interaction effects between Emotion summary T-scores and Hispanic language group on Fluid Cognition T-scores using similar procedures for models by ethnicity described above. Analyses were conducted using JMP software package (version 14.0) and α<.05 was used to determine significance in final models. R version 3.5.0 was used to create all figures.

Results

Sample characteristics

Demographic, HIV disease, psychiatric, and substance use characteristics for the overall sample and stratified by ethnicity are summarized in Table 1. Among demographic, HIV disease, psychiatric and substance use characteristics, Hispanics were significantly younger, had fewer years of education, fewer estimated years of HIV infection, fewer months of exposure to ART, fewer gay or bisexual individuals, lower prevalence of lifetime MDD, lifetime cannabis, and cocaine use disorder than Whites. All other sample characteristics did not significantly differ by ethnicity (Table 1). There were no significant differences on Fluid Cognition T-scores (p = .42) between Hispanics (M = 45.48, SD = 9.91) and Whites (M = 46.44, SD = 10.91), but Hispanics scored lower on the Flanker Inhibitory Control and Attention Test (Hispanics: M = 40.73, SD = 12.27; Whites: M = 43.64, SD = 9.30; p = .03); and the Picture Sequence Memory Test (Hispanics: M = 47.34, SD = 8.76; Whites: M = 49.69, SD = 10.13; p = .03), with no significant ethnic differences on other tests (ps >.14). Within Hispanics, 44 were tested in Spanish and 63 were tested in English, and the majority (80%) were of Mexican origin/descent (i.e., country that participant or family immigrated from).

Table 1. Participant characteristics for the overall sample and stratified by ethnicity

	Mean (SD), Count (%), Median [IQR]			
Variables	Overall (n = 323)	Hispanic (n = 107)	NH White (n = 216)	p-value[†]
Sociodemographic				
Age	53.62 (12.19)	49.32 (11.78)	55.75 (11.85)	**<.01**
Male	279 (86%)	88 (82%)	191 (88%)	.17
Total years of education	13.81 (2.93)	12.35 (3.24)	14.54 (2.48)	**<.01**
Sexual orientation				**.04**
Heterosexual	60 (20%)	28 (27%)	32 (16%)	
Gay	215 (72%)	64 (63%)	151 (76%)	
Bisexual	25 (8%)	10 (10%)	15 (8%)	
Gender identity				.40
Transgender (M to F)	5 (2%)	3 (3%)	2 (1%)	–
Employment (% employed)[a]	91 (37%)	31 (45%)	60 (34%)	.14
HIV Characteristics				
Estimated years of infection	17.67 [10.53, 26.67]	15.91 [9.17, 22.67]	19.59 [11.26, 28.66]	**<.01**
AIDS status	188 (63%)	58 (58%)	130 (65%)	.26
Nadir CD4	190.5 [45, 330]	200 [44, 350]	180 [45, 300]	.20
CD4 absolute	610 [430.5, 823.5]	619 [425, 834]	596 [430.25, 821]	.80
ART on/off (on)	272 (92%)	92 (92%)	180 (92%)	.93
Plasma HIV RNA (% detectable)[b]	23(8%)	9 (9%)	14 (8%)	.65
Months exposure all ART	149.62 (93.97)	134.70 (81.00)	157.24 (99.29)	**.04**
HCV co-infection	48 (16%)	13 (13%)	35 (18%)	.32
Psychiatric characteristics				
Lifetime MDD	170 (56%)	48 (47%)	122 (61%)	**.02**
MDD after estimated HIV infection[c]	97 (57%)	29 (55%)	68 (58%)	.87
Current MDD	23 (8%)	9 (9%)	14 (8%)	.60
Lifetime any substance use Dx	210 (69%)	63 (61%)	147 (74%)	**.03**
Alcohol use Dx	161 (53%)	49 (48%)	112 (56%)	.16
Cannabis use Dx	78 (26%)	15 (15%)	63 (32%)	**<.01**
Cocaine use Dx	63 (21%)	13 (13%)	50 (25%)	**<.01**
Methamphetamine use Dx	117 (39%)	36 (35%)	81 (41%)	.35
Other[*] substance use Dx	73 (24%)	22 (21%)	51 (26%)	.42
Current any substance use Dx	22 (8%)	6 (6%)	16 (9%)	.64

Note. IQR = interquartile range; SD = standard deviation; NH = Non-Hispanic; ART = antiretroviral therapy; HCV = Hepatitis-C; MDD = Major Depressive Disorder; Dx = disorder; NCI = neurocognitive impairment.
[†]Comparisons of ethnic group (e.g. Hispanic vs Non-Hispanic (NH) White) are calculated using χ^2-tests or independent sample t-tests as appropriate.
[a]Indicates n = 246 (69 Hispanics and 177 NH Whites).
[b]Indicates n = 277 (96 Hispanics and 181 NH Whites).
[c]Indicates n = 172 (51 Hispanics and 121 NH Whites).
[*]Other category included hallucinogen, inhalant, opioid, PCP, and sedative substance use.

Table 2 shows descriptive characteristics of the Hispanic sample by primary language. Spanish-speakers were significantly older, more likely to be female, had fewer years of education, and more likely to be of Mexican origin/descent (93.2%), compared to English-speaking Hispanics (73.8% Mexican origin/descent). Spanish-speakers were more likely to present with MDD after HIV disease infection, had significantly longer estimated duration of HIV disease, more months of exposure to ART, were significantly less likely to have a lifetime diagnosis of any substance use disorder, specifically, less likely to have a lifetime diagnosis of methamphetamine or "other" substance use disorder (hallucinogen, inhalant, opioid, PCP, and sedative) than English-speaking Hispanics. All other sample characteristics in Hispanics did not significantly differ by language group (Table 2). There were no significant differences in Fluid Cognition T-scores by primary language group (Spanish-speakers: M = 46.93, SD = 8.07; English-speakers: M = 44.47, SD = 10.97; p = .18), but English-speaking Hispanics scored significantly lower on the Flanker Inhibitory Control and Attention Test (English-speakers: M = 37.78, SD = 13.82; Spanish-speakers: M = 44.97, SD = 8.01; p < .01) and the Picture Sequence Memory Test (English-speakers: M = 45.85, SD = 9.27; Spanish-speakers: M = 49.47, SD = 7.57; p = .03), with no significant differences by language group on other tests (ps > .66).

Emotional health among ethnically and linguistically diverse PWH

Figure 1 presents data on the NIH TB Emotion summary and individual scale T-scores by ethnicity and language group within Hispanics, and comparisons between these groups based on independent sample t-tests.

Regarding negative affect (Figure 1a), there were no significant group differences between Hispanic and White PWH on the summary score or the individual scales. Within Hispanic PWH, Spanish-speakers reported significantly lower anger hostility (Cohen's d = −.62), but higher fear affect (Cohen's d = .34) than English-speakers. After controlling for significant covariates (i.e., age, gender, education, sexual orientation, estimated years of infection, months of exposure to ART, lifetime alcohol, cannabis, cocaine, methamphetamine, and other substance use diagnoses), Spanish-speaking Hispanics still had significantly lower anger hostility ($\beta = -6.82$, 95% CI = −10.88 to −2.76, p = .001) and higher fear affect ($\beta = 5.72$, 95% CI =.88 to 10.56, p = .02). Group mean T-scores of negative affect were generally within five T-score points of the normative mean of 50 for White and Hispanic PWH. Twenty-seven percent of the overall sample showed problematic negative affect scores, with no significant differences between Whites (28%) and Hispanics (23%, p = .35).

Table 2. Participant characteristics for Hispanics stratified by primary language

Variables	Mean (SD), Count (%), Median [IQR]		
	Spanish-speaking Hispanic (n = 44)	English-speaking Hispanic (n = 63)	p-value[†]
Sociodemographic			
Age	54.34 (8.82)	45.81 (12.36)	**<.01**
Male	29 (66%)	59 (93%)	**<.01**
Total years of education	10.84 (3.75)	13.40 (2.33)	**<.01**
Sexual orientation			**<.01**
Heterosexual	18 (42%)	10 (17%)	
Gay	18 (42%)	46 (78%)	
Bisexual	7 (16%)	3 (5%)	
Employment (% employed)[a]	13 (54%)	18 (40%)	.13
Hispanic origin/heritage			**.02**
Mexican	41 (93.2%)	45 (73.8%)	–
Puerto Rican	0 (0%)	3 (4.9%)	–
Cuban	0 (0%)	1 (1.9%)	–
South or Central American	1 (2.3%)	3 (4.9%)	–
Other Spanish origin/heritage	0 (0%)	7 (11.5%)	–
HIV Characteristics			
Estimated years of infection	17.45 (7.86)	14.54 (9.39)	.05
AIDS status	25 (57%)	33 (59%)	.84
Nadir CD4	202.5 [42.5, 349.5]	199 [44, 367]	.54
CD4 absolute	62.5 [453.5, 854.5]	585 [369, 812.5]	.20
ART on/off (on)	39 (87%)	53 (95%)	.30
Plasma HIV RNA (% detectable)	7 (16%)	22 (35%)	.78
Months exposure all ART	151.00 (74.09)	122.02 (84.49)	**.04**
HCV co-infection	6 (14%)	7 (12%)	.77
Psychiatric Characteristics			
Lifetime MDD	23 (53%)	25 (42%)	.32
MDD after estimated HIV infection[b]	18 (72%)	11 (41%)	**.03**
Current MDD	3 (8%)	6 (11%)	.74
Lifetime any substance use Dx	19 (44%)	44 (73%)	**<.01**
Alcohol use Dx	16 (37%)	33 (55%)	.07
Cannabis use Dx	6 (14%)	9 (15%)	.88
Cocaine use Dx	6 (14%)	7 (12%)	.77
Methamphetamine use Dx	7 (16%)	29 (48%)	**<.01**
Other* substance use Dx	5 (12%)	17 (28%)	**.04**
Current any substance use Dx	2 (5%)	4 (7%)	.73

Note. IQR=interquartile range; SD = standard deviation; ART = antiretroviral therapy; HCV = Hepatitis-C; MDD = Major Depressive Disorder; Dx = disorder.
[†]Comparisons of language group (e.g. primarily Spanish-speaking vs primarily English-speaking) are calculated using χ^2-tests or independent sample *t*-tests as appropriate.
[a]Indicates *n* = 51 (24 Spanish speakers and 45 English speakers).
[b]Indicates *n* = 51 (26 Spanish speakers and 25 English speakers)
*Other category included hallucinogen, inhalant, opioid, PCP, and sedative substance use.

Within Hispanic PWH, 26% of English-speakers and 17% of Spanish-speakers showed problematic negative affect scores (*p* = .42), with Spanish-speaking Hispanics showing significantly low anger hostility (*M* = 45.84, *SD* = 10.66) but elevated fear affect (*M* = 56.22, *SD* = 8.76).

Regarding social satisfaction (Figure 1b), Hispanic PWH had significantly higher summary T-scores than White PWH (Cohen's *d* = .22). Both groups showed average scores more than half a *SD* below the normative mean, and 39% of the overall sample showed problematic social satisfaction scores (42% in Whites and 34% in Hispanics, *p* = .14). Hispanics reported significantly less loneliness than Whites (Cohen's *d*=.31). After controlling for significant covariates, there were no longer significant ethnic differences on social satisfaction summary T-scores (β = 2.47, 95% CI = −.18 to 5.11, *p* = .068). However, Hispanics continued to show significantly lower loneliness (β = −3.91, 95% CI = −6.68 to −1.15, *p* = .006) than Whites. There were no significant differences in social satisfaction summary T-score or individual scales by language group within Hispanic PWH, and proportions of problematic social satisfaction scores were notable in both language groups (40% in English- and 25% in Spanish-speaking Hispanic PWH, *p* =.15).

Regarding psychological well-being (Figure 1c), Hispanics showed significantly higher summary T-scores than Whites

(Cohen's *d* = .29), the latter had average scores more than five T-scores below the normative mean (*M* = 44.73, *SD* = 10.11). Thirty percent of the overall sample showed problematic psychological well-being scores (Whites = 32%, Hispanics = 25% in, *p* = .20). Hispanics showed significantly higher meaning and purpose than Whites (Cohen's *d* = .64). After controlling for significant covariates, Hispanics continued to have significantly higher psychological well-being (β = 2.53, 95% CI = .008 to 5.06, *p* = .0492) summary T-scores, and significantly higher meaning and purpose T-scores (β = 3.10, 95% CI = .48 to 5.71, *p* = .02) than Whites. Spanish-speaking Hispanics scored significantly higher on the psychological well-being summary T-score, and on meaning and purpose, than English-speakers, even after controlling for significant covariates (psychological well-being: β = 4.99, 95% CI = .60 to 9.38, *p* = .03; meaning and purpose: β = 9.30, 95% CI = 4.31 to 14.29, *p* = 0.0004). There were no significant language group differences in proportions of problematic psychological well-being sumary scores within Hispanic PWH (English-speakers = 26%; Spanish-speakers=25%; *p* = .93).

Associations between emotional health and cognition among ethnically and linguistically diverse PWH

Table 3 shows results of final models examining the association between NIHTB-EB summary T-scores and Fluid Cognition

Table 3. Results of final multivariable models depicting associations between NIHTB Emotion Battery summary T-scores (negative affect, social satisfaction, and psychological well-being) and Fluid Cognition T-scores among PWH

Predictors	Model A (n = 244)			Model B (n = 283)			Model C (n = 282)		
	β	95% CI	p	β	95% CI	p	β	95% CI	p
NH White Ethnicity	0.84	−2.51, 4.18	.62	0.92	−1.69, 3.52	.49	.83	−1.80, 3.47	.53
EB Summary TS[a]	0.16	−0.32, −0.004	.05	0.14	0.03, 0.25	.01	.04	−0.08, 0.16	.54
NH White ethnicity * EB Summary TS[a]	−0.32	−0.59, 0.05	.02	–	–	–	–	–	–
Estimated Years of Infection	−0.25	−0.45, −0.04	.02	−0.23	−0.40, −0.06	<.01	−.24	−0.41, −0.07	<.01
Months Exposure to ART	0.02	−0.002, 0.04	.07	0.02	−0.002, 0.03	.07	.02	−0.002, 0.03	.08

[a]Represents NIHTB-EB summary TS entered as predictor in each of three separate linear regression analyses: Negative Affect (Model A), Social Satisfaction (Model B), and Psychological Well-Being (Model C). NH = Non-Hispanic; EB = Emotion Battery; TS = T-score; ART = Antiretroviral therapy; β = estimate; CI = Confidence Interval.
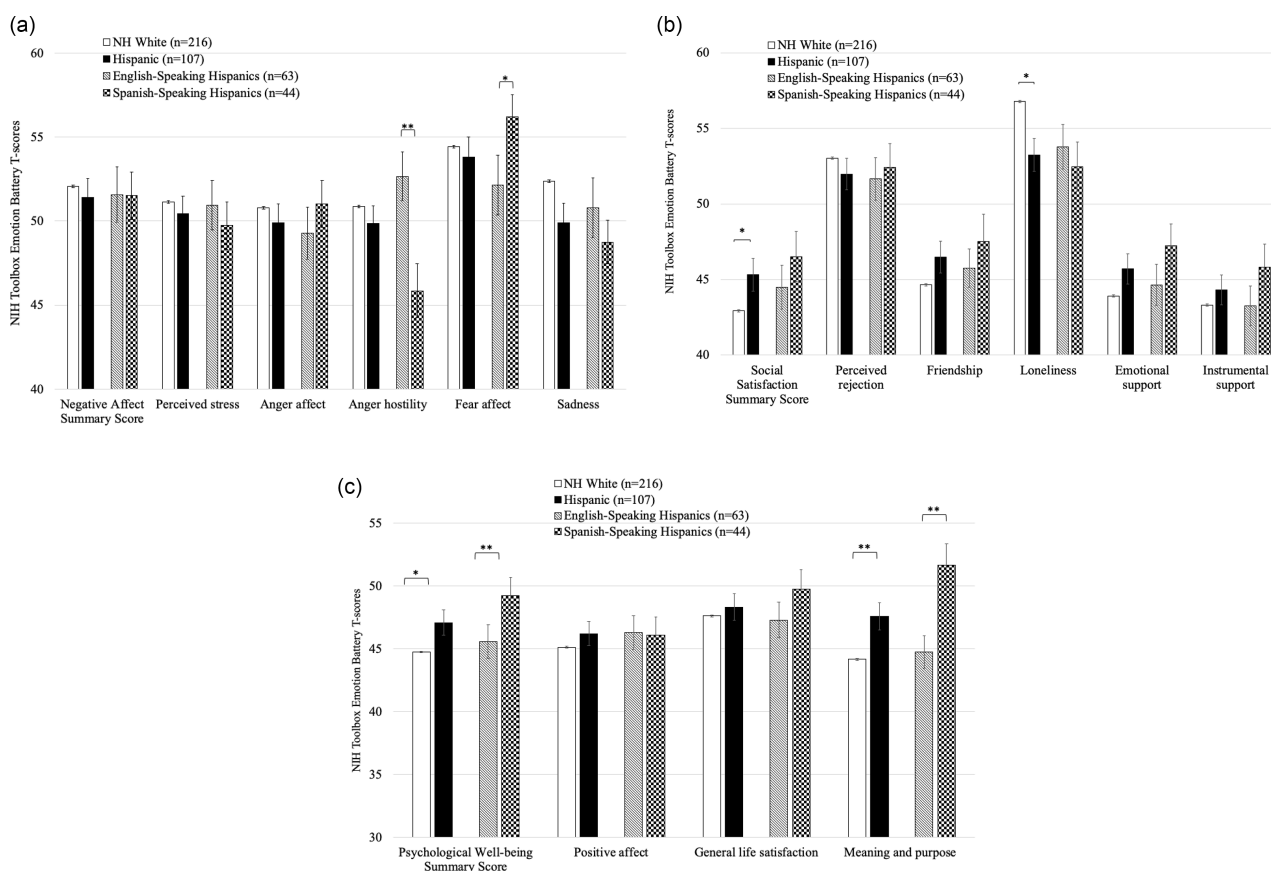
Figure 1. Comparisons on the NIH Toolbox Emotion Battery summary T-scores (Figure 1a: negative affect; Figure 1b: social satisfaction; Figure 1c: psychological well-being) and individual scales comprising these summary scores, by ethnicity (Hispanic vs Non-Hispanic White) and language group within Hispanics (English-and Spanish-speaking) based on independent sample t-tests (unadjusted for covariates). *p < .05, **p < .01.

T-scores by ethnicity, after adjusting for significant covariates. Table 3, Model A depicts the final model results for negative affect, showing a significant interaction (p = .02) between ethnicity and negative affect T-scores on Fluid Cognition T-scores. Follow-up models stratified by ethnicity indicated a significant association between higher negative affect T-scores and worse Fluid Cognition T-scores among Whites (β = −.17, 95% CI = −.32 to −.03, p = .02), but no significant association in Hispanics (β = .16, 95% CI = −.06 to .37, p = .15).

There was no significant ethnicity and social satisfaction interaction on Fluid Cognition T-scores (p = .26). Thus, we removed the interaction term and re-ran the model. Table 3, Model B shows results of the final model for social satisfaction T-scores, such that

there was a positive association between social satisfaction and Fluid Cognition T-scores in the overall sample (p = .01).

We did not find a significant interaction of ethnicity and psychological well-being on Fluid Cognition T-scores (p = .58), therefore we removed the interaction term and re-ran the model. Table 3, Model C shows no significant association between psychological well-being and Fluid Cognition T-scores in the final model (p = .54).

To further understand factors driving the interaction between negative affect and ethnicity on neurocognition, we investigated the individual scales which comprise this summary score as predictors of Fluid Cognition, using separate models comparable to those run using the negative affect summary T-score. Figure 2 depicts
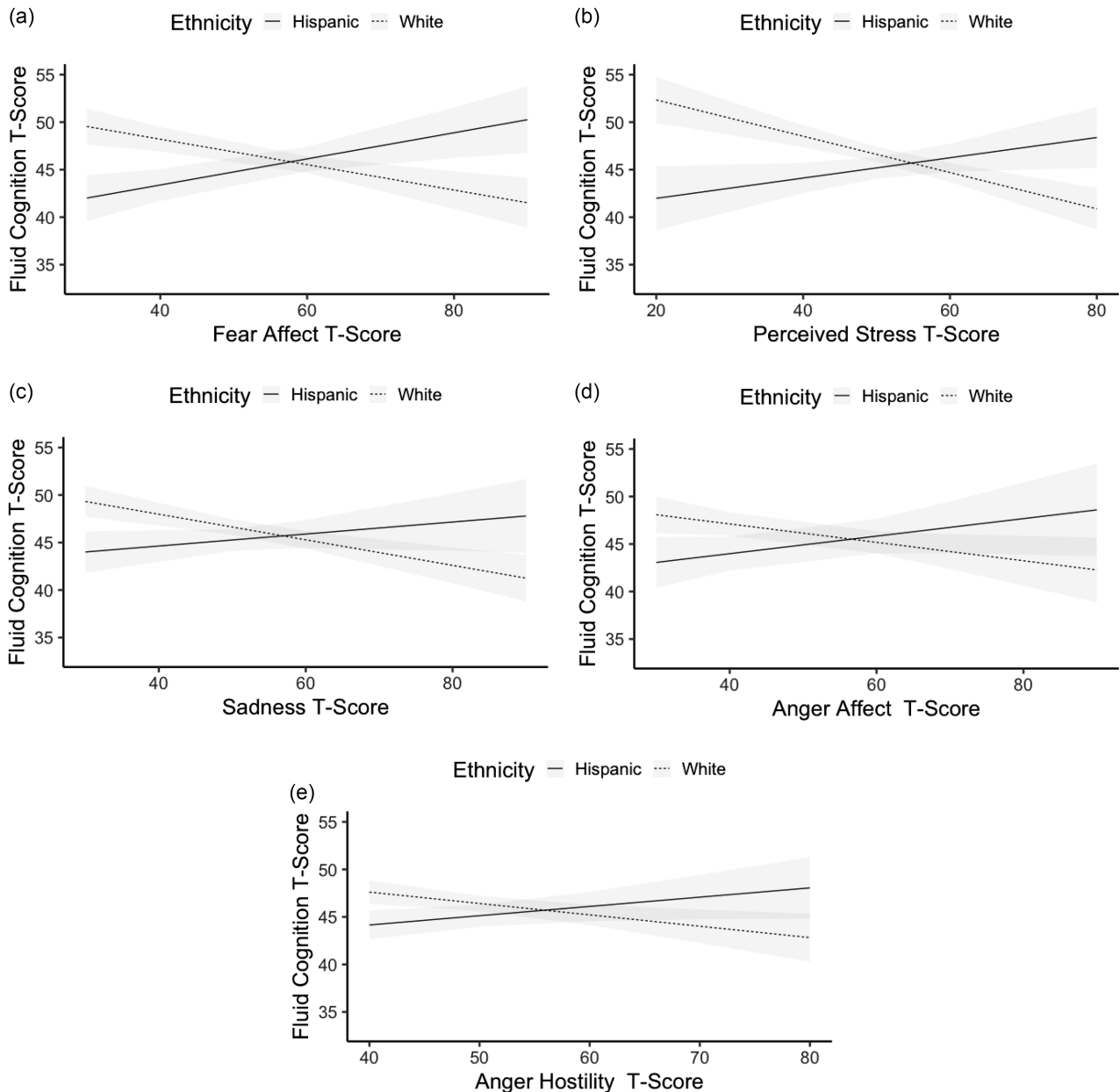
Figure 2. Results from linear regression models examining modifications in associations between scales comprising the NIHTB-EB negative affect summary scores and Fluid Cognition by ethnicity, adjusting for significant covariates. Results from interaction terms for each of the models were as follows:

Fig.2a. Ethnicity X Fear Affect: $\beta = .28$; $SE = .11$; $CI = .05$ to .50; $p = .02$. Fig.2b. Ethnicity X Perceived Stress: $\beta = .33$; $SE = .12$; $CI = .09$ to .58; $p = .008$. Fig.2c. Ethnicity X Sadness: $\beta = .22$; $SE = .11$; $CI = .001$ to .44; $p = .049$.Fig.2d. Ethnicity X Anger Affect: $\beta = .21$; $SE = .15$; $CI = -.09$ to .50; $p = .17$. Fig.2e. Ethnicity X Anger Hostility: $\beta = .22$; $SE = .13$; $CI = -.04$ to .47; $p = .09$.

an interaction, showing higher fear affect ($\beta = -.15$, 95% $CI = -.29$ to $-.008$, $p = .04$; Figure 2a), perceived stress ($\beta = -.20$, 95% $CI = -.34$ to $-.06$; $p = .01$; Figure 2b), and sadness ($\beta = -.14$, 95% $CI = -.26$ to $-.02$, $p = .03$; Figure 2c), were significantly associated with lower Fluid Cognition T-scores in Whites, but not Hispanics (perceived stress: $\beta = .13$, 95% $CI = -.06$ to .31, $p = .18$; fear affect: $\beta = .15$, 95% $CI = -.007$ to .31, $p = .06$; sadness: $\beta = .08$, 95% $CI = -.08$ to .25, $p = .33$). The respective interactions of ethnicity with anger affect and anger hostility on Fluid Cognition T-scores were not significant, and there were no significant main effects of these individual scale T-scores on Fluid Cognition (Figures 2d and 2e; $ps > .05$).

To examine whether specific scales might be driving the main effect of social satisfaction on neurocognition in the overall sample, we ran models comparable to the final model on social satisfaction with each individual scale within this summary score as the predictor. Results revealed that higher emotional support ($\beta = .14$, 95% $CI = .03$ to .25, $p = .02$), higher friendship ($\beta = .19$, 95% $CI = .08$ to .31, $p < .01$) and lower perceived rejection ($\beta = -.13$, 95% $CI = -.24$ to $-.02$, $p = .02$) were significantly associated with higher Fluid Cognition T-scores in the overall sample, while associations with instrumental support ($\beta = .02$, 95% $CI = -.10$ to .14, $p = .75$; Figure 2c) and loneliness ($\beta = -.09$, 95% $CI = -.20$ to .02, $p = .11$) were not significant.

We further assessed if primary language modified the influence of each emotional health summary score on neurocognition among Hispanic PWH. Results showed no significant interaction, such that primary language did not significantly modify the association of negative affect ($\beta = .30$, 95% CI $= -.28$ to $.88$, $p = .31$), social satisfaction ($\beta = -.06$, 95% CI $= -.27$ to $.14$, $p = .55$), nor psychological well-being ($\beta = -.40$, 95% CI $= -.86$ to $.06$, $p = .09$) on Fluid Cognition T-scores among Hispanic PWH.

Discussion

The first aim of this study was to characterize and compare emotional health in Hispanic and White PWH. Importantly, findings reveal that 27%-39% of the present cohort showed problematic scores in at least one aspect of emotional health. Analyses of continuous Emotion summary T-scores showed that Hispanic PWH reported better scores in some aspects of emotional health (i.e., social satisfaction summary, loneliness, psychological well-being summary, and meaning and purpose), though some of these scores were still normatively poor. Within Hispanics, Spanish-speakers reported better scores in some aspects of emotional health (i.e. psychological well-being, meaning and purpose, anger hostility) but worse scores in others (i.e., fear affect) than English-speakers. Our second aim was to investigate the association between emotional health and neurocognition among Hispanic and White PWH. We found that worse negative affect was associated with worse neurocognition in White, but not Hispanic PWH. As for other aspects of emotional health, worse social satisfaction was linked to worse neurocognitive performance across ethnicity, while there was no significant association between psychological well-being and neurocognition.

We also found that there were no significant ethnic group differences on global fluid cognition, but that Hispanics with HIV obtained lower T-scores on some of the individual tests comprising this composite compared to non-Hispanic Whites with HIV. Neurocognitive scores were demographically-adjusted (i.e., accounted for the influence of age, gender, and years education on normal variations on test performance within different ethnic/racial and language groups). Thus, these neurocognitive differences are likely due to factors associated with the experience of living with HIV and being Hispanic, and are in line with prior findings indicating neurocognitive disparities among Hispanics with HIV (e.g., Watson et al., 2022).

A notable proportion of both White and Hispanic PWH showed problematic negative affect, though there were no significant ethnic differences on this summary score nor its individual scales. Yet, Spanish-speakers showed decreased anger hostility (feelings of antagonism or animosity), but increased fear affect (anxiety over perceptions of threat) than English-speaking Hispanics. Primary language among Hispanics in the USA is closely linked to other factors (e.g., acculturation, country of birth, years living in the USA, socioeconomic status) (Fujii, 2017; Hazuda et al., 1988), which might help explain these differences. For example, it might be the case that increased fear affect among Spanish-speakers is related to increased immigration status anxieties in this group, whom are more likely to have been born in a country other than the USA. Future studies directly assessing these factors would be best suited to explain the observed differences. Yet, the present findings underscore the importance of considering Hispanic heterogeneity to best understand emotional health among diverse PWH.

Social support and perceptions of social relationships were notably poor in our sample of PWH, relative to normative expectations. Hispanics showed less severe difficulties in this aspect of emotional health, particularly as it related to feelings of loneliness and social isolation. This is congruent with previous findings showing less loneliness among older Hispanics without HIV than their White counterparts (Zahodne et al., 2018). This prior study also showed higher emotional support, friendship, and instrumental support among Hispanics. As we did not replicate this finding in our sample of PWH, living with HIV might be linked to decreased social support. Additional research should include Hispanics and Whites with and without HIV to best elucidate whether social support is particularly impacted among White PWH.

Psychological well-being was also quite low in our cohort, particularly among White and English-speaking Hispanic PWH. Spanish-speaking Hispanic PWH showed a relative strength in psychological well-being, particularly in feeling that their lives were meaningful. If English language use is interpreted as a dimension of acculturation, these results suggest that greater adherence to Hispanic culture might be linked to higher psychological well-being, particularly higher meaning and purpose. This is in line with prior findings showing higher meaning and purpose in older Hispanics than Whites without HIV (Zahodne et al., 2018).

Worse negative affect was associated with worse neurocognition among White PWH, but not among Hispanic PWH. Analyses within individual negative affect scales showed similar associations by ethnicity related to fear affect, perceived stress, and sadness. This contrasts with another NIHTB study of predominantly White healthy older adults in which negative affect was not associated with neurocognition (Zahodne et al., 2014). Our differing findings might be due to greater prevalence of NCI in PWH relative to the general population. Alternatively, our results suggest that factors specific to Hispanic ethnicity may buffer the adverse impact of negative affect on neurocognition in PWH. For example, less feelings of loneliness could be indicative of a more active social life, and greater socialization could expose individuals to more cognitively stimulating activities.

Social satisfaction had a positive association with neurocognition across ethnicity. This is consistent with prior research showing the benefits of social networks, social support, (Atkins et al., 2010; Bateganya et al., 2015), higher emotional support, higher friendship and less perceived rejection on neurocognition (Kelly et al., 2017; Zahodne et al., 2014). Our findings underscore the potential neurocognitive benefit of interventions to improve social satisfaction among PWH across ethnicity.

Though previous research has indicated significant associations between psychological well-being and neurocognition in adults without HIV (Zahodne et al., 2018), we did not replicate this finding in our sample of PWH. Perhaps the impact of HIV disease on the nervous system or other socioemotional factors (e.g. discrimination, stigma) not presently assessed may help explain our lack of a positive association between psychological well-being and neurocognition among diverse PWH. Future research incorporating people with and without HIV might aid in discerning differing links between positive affect and neurocognition.

Our study has several limitations. First, it was cross-sectional in design, and therefore we cannot attribute causation to the associations observed. Although poor socioemotional health may negatively affect neurocognition, the link between emotional functioning and neurocognition may be in the reverse direction. For example, lower neurocognitive functioning, steeper

neurocognitive decline, and living with a chronic medical condition may contribute to a decline in the quantity and enjoyment of social interactions, resulting in worse emotional health. A longitudinal study would be best suited to address causality between emotional and neurocognitive change over time.

Given differences in age and education across ethnic groups, we considered matching groups one-on-one based on these demographics. However, matching for age would drastically reduce our NH White sample size by more than 50%, and matching based on education would exclude an important segment of the Hispanic population, limiting generalizability of our findings for this group. Thus, we opted for multivariable models adjusting for differences in demographic characteristics as covariates, as this analytical approach allowed us to maximize sample sizes and preserve statistical power (Vittinghoff et al., 2006). Future studies focused on analyzing emotion-cognition associations via a health disparities framework (Hill et al., 2015; National Institute on Minority Health and Health Disparities, 2017) could benefit from recruitment efforts to match participants on key variables.

The generalizability of our results is limited to White and Hispanic PWH living in Southern California. Future research should include other ethnic groups underrepresented in research and/or living in other US regions. While Hispanics other than of Mexican origin/heritage comprised the minority of our Hispanic sample, our Hispanic sample is typical of the US-Mexico border region of Southern California. While there is vast heterogeneity within the Hispanic population in the US, Hispanics in this borderland region share important characteristics (e.g. language use, regional culture). Future larger multisite studies might investigate whether country of origin, US geographic region, and other factors of heterogeneity among US Hispanics modify present findings. While language use is a dimension of acculturation, it is important to recognize the multidimensionality of acculturation was not assessed in our study. As such, measuring Hispanic-specific multidimensional acculturation factors not included in this study such as cultural values, social affiliations, cultural customs or traditions (Schwartz et al., 2010) may help expound differential emotion-neurocognition associations by ethnicity.

The present study also has several strengths. The NIHTB-EB assesses a spectrum of detailed positive and negative emotional health variables providing a comprehensive view of emotional health. Additionally, the composite summary scores used in our analyses were based on psychometrically-supported standards using normative samples with English and Spanish speakers (Babakhanyan et al., 2018). Importantly, our study captures the complexity of emotional health outcomes above and beyond psychiatric diagnoses such as depression and anxiety, which are often times stigmatized, even more so in Hispanic than White groups (Wong et al., 2021). Our study goes beyond analyzing potential emotion-neurocognition differences between Hispanics and Whites by also assessing Hispanics by primary language, thus, recognizing the linguistic heterogeneity of Hispanics in the USA.

Overall, present findings indicate that PWH show notable problems in several domains of emotional health. Yet, some Hispanics, particularly those that are primarily Spanish-speaking, appear to have relative strengths in certain aspects of emotional health. These results are an important step towards developing culturally relevant interventions for diverse PWH. For example, treatments aimed at improving social satisfaction might help promote neurocognitive health among diverse PWH. Interventions focused on ameliorating negative affect, while helpful in their own right to improve emotional health, might be less impactful on neurocognition among Hispanics than Whites. Future studies incorporating assessments of culturally relevant constructs potentially linked to emotional and neurocognitive health may inform the development of adequate treatment of HIV-associated neurocognitive impairment in diverse populations of PWH.

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