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Title
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Permalink
https://escholarship.org/uc/item/6zs732hk

Journal
Journal of Happiness Studies, 20(8)

ISSN
1389-4978

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Publication Date
2019-12-01

DOI
10.1007/s10902-018-0053-5

Peer reviewed

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HHS Public Access
Author manuscript
J Happiness Stud. Author manuscript; available in PMC 2020 December 01.

Published in final edited form as:
J Happiness Stud. 2019 December ; 20(8): 2385–2400. doi:10.1007/s10902-018-0053-5.

Association of Positive Affect with Cognitive Health and Decline for Elder Mexican Americans

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Abstract

The goal of this study was to investigate the linkages of positive affect (PA) with cognitive health and its decline among elder Mexican Americans. We conducted secondary analysis of longitudinal data from the Sacramento Area Latino Study on Aging (SALSA). We used the structural equation modeling framework to achieve three specific aims: (1) identify a valid measure of PA, (2) describe within-person trajectories of PA and cognitive health, and (3) test the inter-relations of these two processes over time. Results showed that, on average, PA and cognitive ability (including verbal memory) decreased over time. Yet, there was significant variability in these patterns of change. Bivariate latent growth curve models showed significant correlations of baseline levels and rates of change of PA and cognitive ability even after controlling for age, education, sex, bilingualism, and depression. Results support the hypothesis that increases and decreases in PA tend to be related to increases and decreases in cognitive health at old age among Mexican Americans.

Keywords

cognitive health; cognitive decline; positive affect; elder Mexican Americans; aging

Cognitive impairments and factors that promote cognitive health in aging populations has become the central focus for much recent research. Indeed, elders' cognitive impairment plays a major role in future disability, which leads to lower quality of life and increased social, emotional, and financial burden on caregivers (Razani et al., 2007). Rapid growth of the aging Mexican-origin population in the United States (U.S. Census Bureau, 2008) makes the study of cognitive health particularly relevant for this population. The elder Latino population (aged 65 or older) was estimated at 2.7 million in 2008 and will grow to 17.5 million by 2050 (U.S. Census Bureau, 2008). By 2019, elder Latinos (65 and older) are expected to represent the largest ethnic minority group in the United States. Despite these trends, little is known about cognitive decline patterns in this population and factors that influence such decline. Research suggests that demographic variables, education, and age-related diseases play a central role in cognitive abilities of aging individuals, particularly

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those from minority populations (Early et al., 2013). These findings paired with the lower educational level of aging Latinos (U.S. Census Bureau, 2008), suggest this population is at a particularly high risk for increased cognitive impairments that interfere with activities of daily life and place a burden on caregivers.

A central consideration for studying cognitive skills with elder Latinos, including Mexican Americans, is the documented heterogeneity in trajectories of cognitive impairment and decline in these populations (Early et al., 2013; Mungas et al., 2010). The heterogeneity in cognitive trajectories suggests there are factors that protect individuals from cognitive decline; identifying such factors has key implications for prevention through interventions. Research focused on understanding cognitive health among elder Mexican Americans, however, is scarce. Most investigations have studied the role of mental and physical health and biological aspects of elder Mexican Americans to understand disparities and cognitive decline in this population (e.g., Raji, Reyes-Ortiz, Kuo, Markides, & Ottenbacher, 2007; Wu et al., 2003). Positive emotional factors have been largely overlooked. Nevertheless, investigations with White samples of adults and elders suggest that positive emotions are linked to better health (Ong, Mroczek, & Riffin, 2011) and lower levels of disability in elders who experience a stroke (Seale, Berges, Ottenbacher, & Ostir, 2010). Thus, the focus of this investigation is to begin to shed light on one positive factor that might influence cognitive health and decline at old age among Mexican Americans. Specifically, we investigate longitudinal patterns of positive affect (PA) and their relation to cognitive health trajectories.

We start by discussing the positive emotions' literature that supports links to cognition and a host of factors also related to cognitive health. We then use data from the Sacramento Area Latino Study of Aging (SALSA) to identify a valid measure of PA and characterize individual trajectories of cognition and PA over a period of 7 years. Latinos in the SALSA study were overwhelmingly of Mexican origin due to the geographical location of where data collection took place. Moreover, we explore the potential association between these two processes in terms of initial levels of the constructs and rates of change across time.

Positive Affect and Cognitive Health

Positive affect is the subjective experience of pleasurable interactions with the environment and is characterized by enthusiasm, energy, mental alertness, interest, joy, and determination (Clark, Watson, & Leeka, 1989). Over the last few decades, experimental research, primarily with White young adults, has shown support for direct effects of PA on cognitive abilities. In a review of the literature, Isen (2008) described various studies documenting that positive emotions enhance cognitive performance on tasks designed to measure creativity, verbal fluency, problem solving, categorization, word association, variety seeking, reasoning, perspective taking, and decision making. More recent work has also shown that PA improves working memory and, to a lesser extent, short-term memory, and those effects are due to improved control in cognitive processing rather than motivation (Yang, Yang, & Isen, 2013).

Partly guided by the early body of literature linking PA and cognition, Fredrickson (1998, 2001) introduced the broaden-and-build theory, which suggests positive emotions broaden

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attention and cognition, which results in an increase of resources for individuals in the form of improved physical and psychological health, positive social relationships, and increased knowledge. Indeed, a variety of recent studies suggest that PA is associated with lower morbidity, pain, risk of AIDS mortality, and patients' physical symptoms, as well as increased longevity and better cardiovascular health (Boehm & Kubzansky, 2012; Howell, Kern, & Lyubomirsky, 2007; Moskowitz, 2003; Ostir, Markides, Black, & Goodwin, 2000; Pressman & Cohen, 2005). Moreover, Fredrickson and colleagues' experimental work shows that positive emotions undo the cardiovascular effects produced by anxiety (which tends to co-occur with depression) and might also counter other negative emotions involved in depression and schizophrenia (see Garland et al., 2010, for a review). Also, numerous investigations have shown that PA leads to increased social activities and higher quality conversations and relationships (see Lyubomirsky, King, & Diener, 2005, for a review).

Of importance to this investigation are studies conducted with aging populations. Reviews of this literature support a protective effect of PA and psychological well being on self-reported health, physical functioning, symptom severity, and mortality in predominantly White samples (Chida & Steptoe, 2008; Ong et al., 2011). One study using a Danish sample examined how levels and subsequent *changes* in positive emotion were related to functional limitations (such as walking, climbing stairs, and carrying objects of specific weight) over a 6-year period. Results showed that higher levels of positive emotions at baseline and increases in positive emotions were associated with less decline in functional limitations (Brummett, Babyak, Grønbaek, & Barefoot, 2011). Notably, cognitive impairments are known to precede limitations (Royall et al., 2007), which supports the notion that cognitive decline might the linkages between PA and functional limitations.

Theories of emotional aging, such as socioemotional selectivity theory (Carstensen & Charles, 1998) and dynamic integration theory (Labouvie-Vief, 2003), also suggest links between cognition and PA. Specifically, these theories posit cognitive ability as a determinant of emotion regulation strategies that involve executive control. Thus, it is likely that PA not only influences cognitive health but that associations across constructs are reciprocal. Such relations would manifest themselves as significant associations between levels and changes in PA and levels and changes in cognitive ability.

The few investigations that have been conducted with aging Mexican American samples suggest that the benefits of PA on health transcend race and ethnicity. For example, in a prospective study of 2,282 Mexican Americans between 65 and 99 years of age, those with higher PA (assessed with four positively-worded items from the Center for Epidemiologic Studies Depression Scale; CES-D; Radloff, 1977) at baseline were less likely to become disabled or die 2 years later (Ostir et al., 2000). Also, a longitudinal study of 3,050 older Mexican Americans found that religious attendance (a proxy for social engagement) was associated with slower cognitive decline (Hill, Burdette, Angel, & Angel, 2006). It is possible that positive emotions evoked through social engagement in religious services mediated the latter association. Other studies with Mexican Americans also show support for the negative association of psychosocial resources and PA with factors such as cognitive functional limitations and blood pressure (Hazuda, Wood, Lichtenstein, & Espino, 1998; Ostir, Berges, Markides, & Ottenbacher, 2006). However, conclusions from those studies are

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limited by their cross-sectional designs. Thus, to date, research has not focused on examining associations of PA and cognitive decline in the Mexican American population using longitudinal designs and rigorous methodology.

The Present Study

The literature on PA suggests both direct and indirect pathways through which PA might influence cognitive health at old age, and emotional aging theories presume cognitive ability as a determinant of changes in PA. However, to our knowledge, there are no longitudinal investigations that 1) test associations between levels and changes in PA and cognitive ability and its decline in elders, 2) use a community sample of Mexican Americans, and 3) use advanced methodology to characterize individual trajectories of change in PA and cognitive ability. We address this gap in the literature in the present study. Using data from the SALSA project, we examined trajectories of PA and cognitive ability over 7 years among 1,785 Mexican Americans aged 60 or older. We used two cognitive measures administered in SALSA: verbal memory (VM) and the Modified Mini-Mental State (3MS; Teng & Chui, 1987) test. The VM scale was created with modern test theory methods and has sound psychometric properties (González, Mungas, Reed, Marshall, & Haan, 2001), and we used similar methods to obtain valid scores for the 3MS. Based on our review of the literature, we hypothesized that initial levels and changes in PA would be positively associated with initial levels and changes in cognitive ability.

Method

Participants

Participants were part of the SALSA project, a community-dwelling study of Mexican Americans in the Sacramento area of California. Starting in 1998 and 1999, 1,789 participants (M_{age} = 70.6, 58.4% female) were recruited to participate in the study and were assessed every 12 to 15 months for up to 7 years. To be eligible, participants had to be at least 60 years of age and self-identify as Latino. Census tracts from 1990 were used to identify the target population. Eligible residents were contacted by mail, phone, and directly at their households. The response rate from those contacted was 85%. All eligible household residents were allowed to participate. Participants varied substantially in their years of education; 13.4% had no formal education, 47.5% had 1 to 8 years of education, 9.9% had 9 to 11 years, 12.7% had 12 years, and 16.5% had more than 12 years of education. Moreover, 45.4% reported being born in Mexico and 57.9% indicated their primary language was Spanish. Four participants were excluded from the present analyses because they had missing data in all variables considered in this study.

Data Collection

Interviews were conducted at participants' households in their language of choice by trained staff who were bilingual in Spanish and English. Participants answered questions about lifestyle, depressive symptoms, acculturation, and medical diagnoses. Two cognitive screening tests, the 3MS (Teng & Chui, 1987) test and the Spanish and English Verbal Learning Test (SEVLT; González et al., 2001), were administered and participants were

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referred to additional neuropsychological testing if their scores fell below the 20th percentile. If participants were unable to give verbal responses, had a score of less than 40 on the 3MS test, or a caregiver volunteered to answer questions, a proxy interview was administered that only contained questions appropriate for a third party. The institutional review boards of the University of California at San Francisco and Davis and the University of Michigan approved the SALSA project. Moreover, all participants provided written informed consent. Additional details on the procedures in SALSA have been published elsewhere (Haan et al., 2003).

Measures

Positive Affect.—Four positively-worded items from the Center for Epidemiologic Studies Depression (CES-D; Radloff, 1977) scale were selected based on psychometric analyses that supported their validity for assessing PA. The items were “I enjoyed life,” “I was happy,” “I felt hopeful about the future,” and “I felt that I was just as good as other people.” Four response options followed each item with 0 = *Rarely or None of the Time* and 3 = *Most or Almost All the Time*. Coefficient alpha for the four items ranged from .72 to .74 across years of assessment, with exception of years 1 and 2 for which coefficient alpha was .53 and .66, respectively. We computed a sum score for PA at each measurement occasion ranging from 0 to 12, with higher scores representing higher PA.

Cognitive Ability.—The 3MS (Teng & Chui, 1987) was used to measure global cognitive functioning. The 3MS was translated and back translated from English to Spanish. Item response theory methods (IRT) were used to score the 3MS. Previous publications from the SALSA project have shown that the 3MS is related to a diagnosis of dementia, (Haan et al., 2003) to structural and functional brain imaging (Haan et al., 2003; Jagust et al., 2006), to the presence of a metabolic syndrome, (Yaffe et al., 2007) diabetes (Mayeda, Haan, Yaffe, Kanaya, & Neuhaus, 2015), and to folate deficiency (Ramos et al., 2005).

VM was assessed using the SEVLT (González et al., 2001). The SEVLT uses a 15 word list that is presented for five learning trials in a standard word-list learning test format, followed by presentation of a distractor task, and then by free recall of the initial list. The VM measure was constructed with IRT methods using the learning and delayed recall trials’ scores. This measure has been shown to be sensitive to clinically relevant cognitive change as well as to MRI measures of brain structure (Farias et al., 2012; Mungas et al., 2010; Mungas, Reed, Farias, & DeCarli, 2009).

IRT scores for cognitive ability and VM were transformed to have a mean of 100 and standard deviation of 15 using the mean and standard deviation of the baseline assessment. Additional details on the IRT models and analyses are in supplemental material.

Covariates.—Five different variables were included in our models as covariates: age, years of education, sex (0 = female, 1 = male), bilingualism (0 = not bilingual, 1 = bilingual), and depression. For the latter, we created a sum score using all negatively-worded items in the CESD (Radloff, 1977) across all waves of assessment.

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Data Analysis

We assessed the psychometric properties of the CES-D to test whether positively worded items in the scale measure a PA factor that is distinct from depression in this population. Taking advantage of our large sample, we randomly selected half of the participants and used their data to conduct exploratory factor analyses (EFA). We used EFA, rather than relying on past psychometric analyses of the CES-D, to test empirically the assumption that a PA factor can be captured in these data. We cross-validated results from the EFA with a confirmatory factor model using the other half of the sample. We conducted these analyses separately for each measurement occasion and also tested longitudinal factorial invariance. After establishing the validity of our PA construct, we fit univariate latent growth curve models in the structural equation modeling framework (see Figure 1a; Meredith & Tisak, 1990) to characterize individuals' trajectories in PA, the 3MS, and VM.

Practice effects in cognitive tests have been documented to improve performance during the first two -and to a lesser extent three- administrations of the test, making it difficult to assess the amount of change in cognitive abilities (Wilson et al., 2002). Thus, to account for practice effects in our cognitive measures, we explored the fit of piecewise latent growth curve models (or spline models; Duncan, Duncan, & Strycker, 2013) with a knot point at the third measurement occasion. This allowed us to examine separately individuals' rates of change from baseline to the third measurement occasion, and from the third occasion to the 7th year of data collection. Finally, we fit two bivariate piecewise latent growth curve models (see Figure 1b) in which we assessed the relation of individuals' baseline levels and rates of change in PA and 3MS as well as PA and VM. In these final models, we accounted for the effects of age, education, sex, bilingualism, and depression by including these variables as predictors of baseline levels and rates of change of each of the processes under consideration.

EFAs were conducted in R (R Core Team, 2013) and all other analyses in Mplus v.7.1 (Muthén & Muthén, 1998–2012). Missing data were handled with full information maximum likelihood and robust standard errors were estimated for growth curve models. Where available, we used the comparative fit index (CFI) and root mean square error of approximation (RMSEA) to assess the fit of our models. A CFI value of .90 suggests reasonable fit, whereas .95 or higher indicates excellent fit (Hu & Bentler, 1999). RMSEA values under 0.08 reflect adequate fit and values below 0.05 reflect excellent fit (Browne & Cudeck, 1993). We also used log likelihood (LL) ratio tests with the appropriate scaling correction factor (when robust standard errors were estimated; Satorra & Bentler, 2001) to compare the appropriateness of competing nested models.

Results

Preliminary Analyses

The EFA supported a 4-factor structure for the CES-D. One of the four factors only had positively worded items loading onto it, supporting the existence of a PA factor within the scale. Cross-validation via confirmatory factor analysis also suggested that positively worded items measure a dimension of PA that is distinct from depression. In Table 1, we

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present results from separate confirmatory factor analyses by measurement occasion. Standardized factor loadings across occasions, except time 1, suggest that the four positively worded items are good indicators of PA. The bottom half of Table 1 shows the correlations of the PA factor with the other three dimensions of depression identified through EFA. These correlations range from a minimum of .33 to a maximum of .87 (median = .66), suggesting that the overlap in variability between PA and the three facets of depression range from 11% to 76% (median = 44%), leaving substantial unique variance of PA.

Further longitudinal factorial invariance analyses of the PA factor showed evidence for partial strong invariance over time. These analyses are also available from the first author upon request. Psychometric analyses provided sufficient reassurance of the validity and reliability of the PA variables, and thus for parsimony, we computed a sum score for PA at each measurement occasion. To handle the skewed distribution of the sum score (i.e., ceiling effect), we specified the growth models with censored distributions for all PA manifest variables. That is, we did not assume the PA items were continuous; instead, specifying censored distributions accounted for the skewness in the data (Muthén, 1989).

Longitudinal Change Over Time

Longitudinal trajectories of PA, the 3MS, and VM for a random sample of 100 individuals are displayed in Figure 2. Gray lines represent individuals' trajectories over the 7 years of assessment, whereas the bold line is the average trajectory for the full sample. Panels in Figure 2 illustrate a large degree of heterogeneity in PA, 3MS scores, and VM. Figure 2a suggests that Mexican American elders report relatively high levels of PA, although there seems to be a slight overall decline over the course of the study. Practice effects over the first three waves of assessment are obvious in the mean trajectory of the 3MS (Figure 2b), and are less noticeable in the mean trajectory of VM (Figure 2c). Starting on the third measurement occasion, average cognitive scores in the 3MS and VM have a slight decline, but individual trajectories suggest that not everyone fits that pattern of change.

We fit univariate latent growth curves to identify individuals' patterns of change in each construct as accurately as possible prior to examining associations across processes. A linear growth curve with homogeneity of residual variances across time for PA provided significantly better fit to the data than a no growth model, $\Delta\chi^2(4) = 699.32$, $p < .001$, but significantly worse fit than one with heterogeneous residual variances, $\Delta\chi^2(6) = 58.96$, $p < .001$. The better fitting model suggested that PA at baseline is high, $\mu_{PA0} = 11.51$, $SE = 0.01$, $p < .001$ and declines significantly every year, $\mu_{PA1} = -0.03$, $SE = 0.003$, $p < .001$. However, there was significant variability in the intercept, $\sigma^2_{PA0} = 0.10$, $SE = 0.01$, $p < .001$, and slope $\sigma^2_{PA1} = 0.003$, $SE = 0.001$, $p < .001$, confirming the notion that not all elders' PA follows this pattern. Also, the intercept and slope in the model were not significantly correlated, $r = -.25$, $p = .14$, suggesting that baseline levels of PA did not influence whether there would be increases or decreases over time.

A univariate linear growth model with homogeneous residual variances for the 3MS was significantly better than a no growth model, $\Delta\chi^2(4) = 4895.24$, $p < .001$, but significantly worse than one with heterogeneous residual variances, $\Delta\chi^2(6) = 66.52$, $p < .001$. A spline model for the 3MS scores further improved fit to the data, $\Delta\chi^2(4) = 341.09$, $p < .001$ and

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had adequate fit, CFI = .95 and RMSEA = .09, so we retained this model. Because the knot point in the spline model was set at the third wave of assessment, the mean of the intercept represents the average 3MS score at the 3rd year of the study. This mean was positive and significant, μ_{3M0} = 0.25, SE = 0.02, p < .001, as was the mean of the first slope, μ_{3M1} = 0.16, SE = 0.009, p < .001, suggesting that over the first 3 years, the average 3MS score improved by 0.16 each year. As expected, the mean of the second linear slope was negative and significant, μ_3M2 = −0.06, SE = 0.006, p < .001, pointing to an overall decrease in the 3MS starting on the 3rd year of assessment. Variances for all growth factors were also significant (σ^2_{3M0} = 0.51, SE = 0.03, p < .001, σ^2_{3M1} = 0.03, SE = 0.007, p < .001, and σ^2_{3M2} = 0.01, SE = 0.002, p < .001, for the intercept, first, and second slope respectively), leading to the conclusion that elders' 3MS scores followed patterns different from that of the average trajectory. Furthermore, growth factors were significantly correlated, r =−.18, .46, and −.24, all p < .05, for the intercept-first slope, intercept-second slope, and first-second slope correlations, respectively. These associations suggest that higher scores, or increases, in the first 3 years are associated with lower scores in the intercept, that is, the 3rd year of assessment, and higher scores at the 3rd year are associated with increases from the 3rd year onward. Also, those who increased over the first 3 years were more likely to decrease over the last 5 years of the study.

A third univariate linear growth model for VM with homogeneity of residual variances also fit significantly better than a no growth model, $\Delta\chi^2(4)$ = 3324.81, p < .001, and significantly worse than a model with heterogeneous residual variances, $\Delta\chi^2(6)$ = 13.01, p = .04. Although the latter test is not of practical significance (the likelihood ratio test is influenced by our large sample size and the change in chi-square is not substantial), further tests with the spline model suggested the homogeneity of variance assumption was not tenable. The linear model with heterogeneous residual variances fit significantly worse than the spline model with heterogeneous residual variances, $\Delta\chi^2(4)$ = 64.84, p < .001, and an additional test setting residual variances to equality over time suggested such constraints were not appropriate, $\Delta\chi^2(6)$ = 32.34, p < .001. Thus, when the trajectory of VM is assumed to be linear over the whole study, homogeneity of variance is an appropriate assumption. Yet, when the growth trajectory is nonlinear (i.e., represented by two linear slopes), residual variances are more accurately represented as different over time. Because practice effects are a common issue in cognitive testing, we retained the spline model with heterogeneous residual variances. Fit indices for this final model suggested acceptable fit to the data, CFI = .94, RMSEA = .08.

The spline model for VM had a significant positive mean of the intercept μ_{VM0} = 99.44, SE = 0.35, p < .001, a non-significant mean for the first slope, μ_{VM1} = −0.18, SE = 0.17, p = .28, and a significant negative mean of the second slope, μ_{VM2} = −0.47, SE = 0.12, p < .001, pointing to an average decrease in VM from the 3rd year onward. As with the 3MS, all growth factors had significant variability, σ^2_{VM0} = 117.62, SE = 7.23, p < .001, o\m1 = 11.37, SE = 2.57, p < .001, and σ^2_{VM2} =4.29, SE = 0.68, p < .001, for the intercept, first, and second slope respectively; thus, the average trajectory did not characterize the pattern of change for all elders. The correlation of the intercept and second slope, as well as that of the two slopes were significant (r = .24 and −.25, p = .003 and .05, respectively), suggesting that higher VM scores at time 3 were associated with higher scores in the second slope factor.

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Relatedly, higher scores in the first slope were associated with lower scores in the second one.

Associations of Growth Factors Across Constructs

With accurate representations of change in PA, 3MS scores, and VM, we proceeded to fit bivariate growth curve models to assess the associations of growth factors across processes. Fit indices for these models were not available due to the specification of censored distributions for the PA sum scores. In the first bivariate model we examined the covariation of PA and cognitive ability in the 3MS over the duration of the study. Correlations of growth factors for these two processes are displayed in the top half of Table 2. The intercept of PA was significantly associated with the intercept of the 3MS, $r = .62$, $p < .001$, suggesting that those with higher levels of PA in the first measurement occasion were more likely at the 3rd wave of assessment to have higher scores in the 3MS. Moreover, the rate of change in PA was positively associated with the rate of change of the 3MS from the 3rd to the 7th year of assessment, $r = .44$, $p = .002$. This indicates that elders who increased in PA over time were more likely to exhibit increases in the 3MS and vice versa. The intercept and slope factors of the 3MS were also significantly correlated, $r = -.18$ and .45, $p = .046$ and <.001, for the first and second slope, respectively, suggesting higher levels of cognitive ability in year 3 were related to lower rates of change during the first 3 years and higher rates of change over the last 5 years of the study.

In the second bivariate model we assessed the association of growth factors of PA and VM. Results from this model are in the bottom half of Table 2 and follow a very similar pattern to those with the 3MS. That is, there was a positive correlation of the PA and VM intercepts, $r = .44$, $p < .001$, the PA slope and the second slope of VM, $r = .46$, $p < .001$, and the intercept and second slope of VM, $r = .26$, $p = .007$. These results point to a positive temporal association between levels of PA at the 1st year of assessment and VM at the 3rd year of assessment, and a positive association in rates of change across processes, and within VM, over time.

All variance estimates for growth factors in both bivariate models were significantly different from zero and are displayed along the diagonals of Table 2. These estimates confirm the variability in developmental trajectories of Mexican origin elders. Importantly, the pattern of results from the bivariate models remained even after controlling for age, years of education, sex, bilingualism, and depression.

Discussion

This study examined interdependence of PA and cognitive health and decline at old age among Mexican Americans. The literature on PA suggests that not only can PA have a direct link to cognitive skills and their decline at old age, but it can also have indirect effects through its influence on mental health, physical health, quality of social relationships, and creativity (Fredrickson, 2001). Results supported our hypotheses and pointed to linkages across levels and rates of change of PA and cognitive abilities. We found that, on average, the three processes under consideration (PA, 3MS, and VM) showed declines over time, but there was ample heterogeneity in individuals’ trajectories, supporting previous research

(Mungas et al., 2010). Our statistical models allowed us to assess the covariation across processes and we found that individuals with higher levels of PA at the 1st wave of assessment were more likely to have higher scores in 3MS and VM at the 3rd year of participation in the study. Most importantly, those who had increases in PA over time were more likely to also increase, or have diminished declines, in the 3MS and VM over time and vice versa.

Our results are in line with other investigations of Mexican Americans that find PA and psychological resources are associated with lower rates of mortality, functional limitations, and blood pressure (Hazuda, et al., 1998; Ostir, et al., 2006; Ostir, et al., 2000). Here, we extend this literature by showing that PA and patterns of change in PA are also related to cognitive ability and its decline.

Our review of the literature on cognitive health and its antecedents revealed that most investigations have focused on the negative spectrum of mental and physical health. For example, linking depressive symptomatology, or a myriad of physical illnesses, to cognitive impairments at old age and its decline (e.g., Wu et al., 2003). These investigations are vital, but positive cultural, social, and affective factors should not be overlooked. If one seeks to identify factors that deflect cognitive decline, then focus on positive psychological processes that improve mental, physical, and cognitive health can be valuable for designing intervention programs. Undeniably, individuals will be more likely to participate in interventions that are enjoyable rather than boring or upsetting. More importantly, it might be easier to help elders savor everyday life and increase their experience of PA than to manage physical illnesses that often are comorbid. This is not to say that physical complaints should be ignored, but rather, interventions should be aimed at improving both physical and psychological health.

Although in this study we focused on longitudinal relations between PA and cognitive ability, our findings also shed light on theories of emotional aging that suggest that patterns of cognitive ability influence PA in elders. Specifically, socioemotional selectivity theory (SST) posits that as individuals age and perceive a shorter time to death, their motivation to select and pursue positive experiences increases, which leads to increases in PA (Carstensen & Charles, 1998). SST affirms that cognitive health is required to exhibit increases in PA, or a positivity bias. Thus, SST suggests a positive association between cognitive health and PA. Alternatively, dynamic integration theory (DIT) suggests that the positivity bias is the result of declines in cognitive resources that limit elders' capacity for complex emotion regulation st rategies, which ultimately leads to unconscious enhancing of PA (Labouvie-Vief, 2003). Thus, DIT suggests a negative association between cognitive health and PA. The positive associations we observed between PA and cognitive decline in this study show support for SST and not DIT. That is, elders with little or no declines in cognition (i.e., higher scores in the slope factor of cognitive ability) tend to have increases in PA (i.e., higher scores in the slope of PA).

As implied above, we believe PA and cognitive health have reciprocal effects and future research is needed to assess potential causal effects across these two processes. Such research could inform whether one process exerts stronger effects on the other over time.

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Implications for the Mexican American Population

Latinos in the United States, including those of Mexican origin, undergo high levels of stress, are subject to discrimination, and have low levels of support in multiple domains (Conger et al., 2012). These factors could account for lower levels of PA, which might lead to increased risks for lower mental and physical health, and ultimately more cognitive decline in old age. On the contrary, there are unique aspects of the Mexican-origin culture that play a role in the experience of PA. For example, the values of respect for elders and familism (i.e., the notion that family should be united, prioritized, and supportive of each of its members) have been shown to evoke PA in this population (Beyene, Becker, & Mayen, 2002). Unfortunately, few investigations of Mexican American elders have called attention to these culture-specific factors and their influence on cognitive health. Nevertheless, the recent push toward considering disability (which often ensues cognitive impairments) within the context of sociocultural factors is encouraging (Hazuda & Espinoza, 2012).

Indeed, much research is needed with middle-aged and older Mexican Americans to investigate the links of contextual and cultural factors on PA, which according to this investigation is associated with better cognitive health. Inclusion of culture-specific factors outlined above in longitudinal investigations will provide unique opportunities for designing interventions that promote PA and well-being for elder Mexican Americans.

Limitations

Despite the strengths of our study, some limitations should be considered. First, our measure of PA is not ideal. We conducted careful psychometric analyses that gave us confidence in our assessment of a facet of PA that is distinct from depression, but the items we had do not assess the full spectrum of PA, which is partly reflected by ceiling effects in the data. Moreover, PA and positive wording of the items are confounded in our analyses. Possibly, some variance in the PA factor is due to wording effects but the data did not enable us to quantify it. Similarly, the low alpha coefficients from the first two waves of PA data are less than ideal, but it was encouraging to find meaningful associations despite the larger amount of noise in the two waves of data. Future investigations should consider administering a validated scale of PA to enable potential replication of our results. Second, despite the longitudinal design of the study and the advanced methods for characterizing individuals' trajectories over time, our findings are not based on experimental manipulations that lend themselves to inferences of causality. Future experimental research could inform whether PA has a causal link to cognitive health at old age. In the absence of experimental work, finding dynamic (i.e., moment-to-moment) relations between PA and cognitive health and decline would provide stronger evidence for the connection between these processes. Relatedly, lead-lag analyses will be required to rule out the possibility that cognitive ability fully drives the trajectories of PA. That is, the directionality of effects remains unclear and future studies should aim to clarify this issue.

Also, our assessment of longitudinal trajectories in all processes was not exhaustive. We did not explore, for example, quadratic or exponential trajectories. Instead, we favored the spline models for cognitive health because they facilitate accounting for practice effects and for their straightforward interpretation. For PA, the linear model enabled us to capture

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oscillations by quantifying individuals' departures from the average trajectory. Nevertheless, more nuanced trajectories could be explored in future work to reveal more granularity in how these processes are related.

Conclusion

In sum, our study found support for the association of PA with cognitive health and its decline. Our findings stress the need for future work to inform whether PA has the potential to promote cognitive health and deflect cognitive decline in aging Mexican Americans. This population has been understudied and yet, national projections of population growth (U.S. Census Bureau, 2008) suggest elder Latinos are extremely important in the United States as they will soon represent the largest ethnic minority aged 65 or older. As such, additional research is needed to uncover key factors that can be used in interventions to improve the quality of life of older Latinos, including Mexican Americans.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Item Response Theory Models

Cognitive outcomes included the 3MS and the Spanish and English Verbal Learning Test (SEVLT, i.e., verbal memory). The 3MS was not normally distributed, and like the Mini Mental State Exam from which it was derived, does not provide linear measurement across the ability continuum (Mungas & Reed, 2000; Mungas, Reed, Crane, Haan, & González, 2004). That is, a one unit difference in total score at the upper end of the 3MS scale is associated with a substantially larger difference in underlying ability than a one unit difference at a lower score. To address this problem, we used item response theory (IRT) methods to calibrate and score the 3MS. We used baseline scores for calibration. We recoded individual item scores into ordinal scores with 10 or less categories and used R ltm (Rizopoulos, 2006) to fit a graded response IRT model (Samejima, 1969). Item parameters were then used to estimate IRT theta scores using an empirical Bayes scoring algorithm. IRT scoring has a distinct advantage in that it maps test performance onto a linear measurement scale. However, it does not completely solve the measurement limitations of the 3MS because high ability is measured with less precision than low ability. The IRT score from the 3MS was reasonably normally distributed and so was appropriate for subsequent analyses. The baseline evaluation mean and standard deviation of the 3MS IRT score were used to transform the score to have a mean of 100 and standard deviation of 15. VM was an IRT based composite measure combining scores from the learning trials and delayed recall trials, described in a previous publication (Mungas et al., 2004). It also was scaled to have a mean of 100 and a standard deviation of 15 in the baseline SALSA sample.

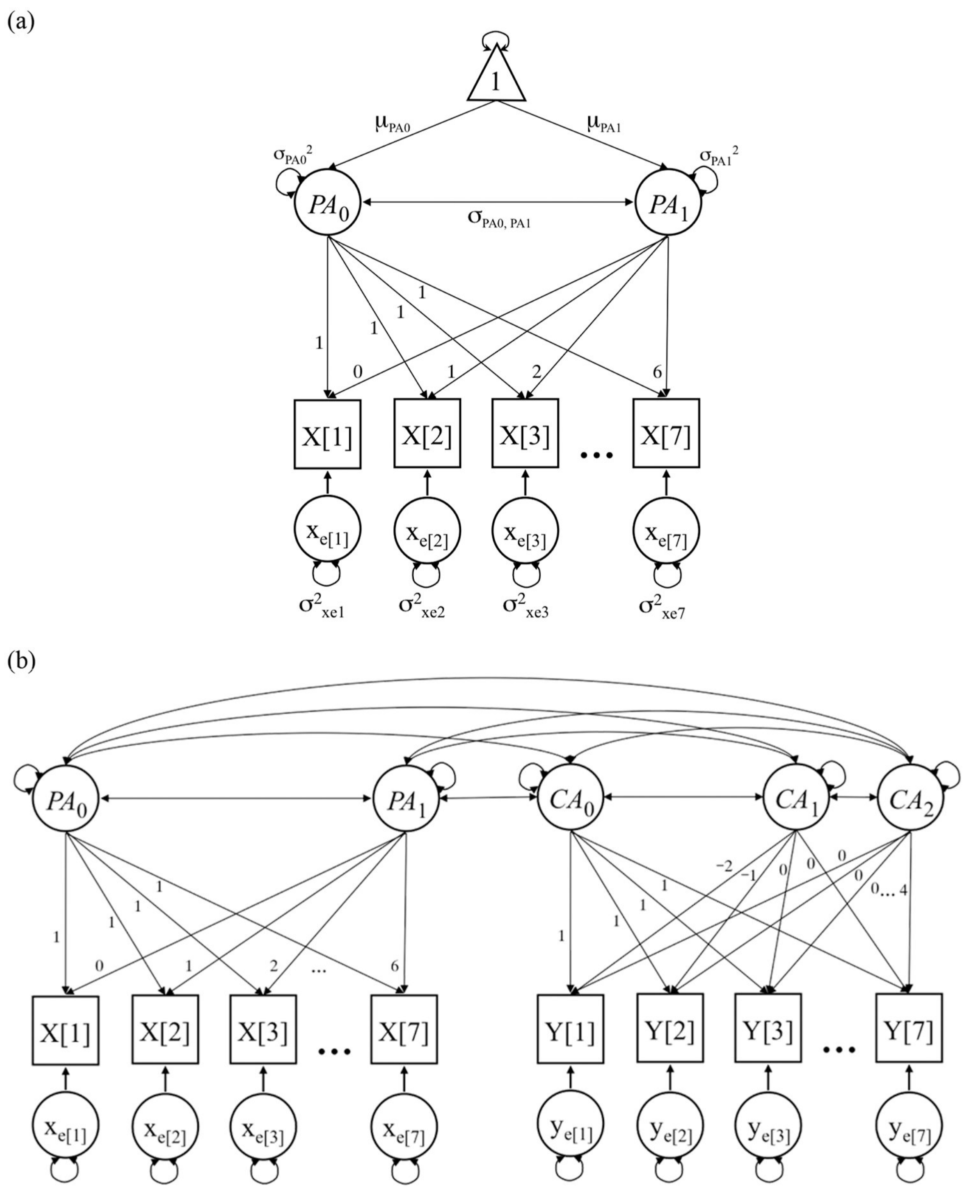

Figure 1.

(a) Linear latent growth curve model of positive affect (PA). (b) Bivariate piecewise latent growth curve model of positive affect (PA) and cognitive ability (CA). Although not depicted in panel b, means for the growth factors are estimated. For clarity, parameters are not labeled in panel b.

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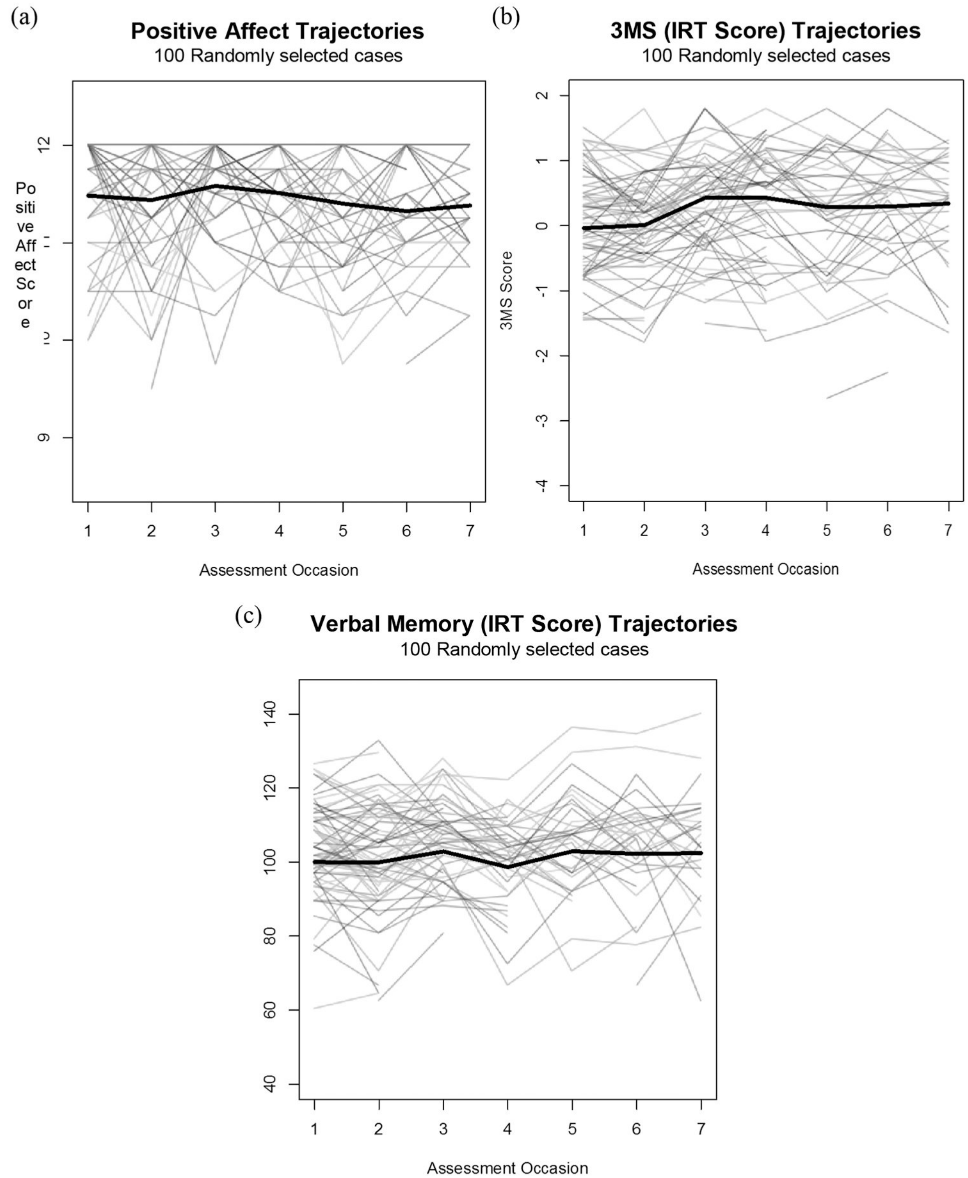

Figure 2.

Longitudinal trajectories of (a) positive affect, (b) cognitive ability in the 3MS, and (c) verbal memory for a random sample of 100 elders. Gray lines represent individuals' scores over time, whereas bold black lines show average trajectories across the full sample over the course of the study.

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Table 1.

Standardized Factor Loadings for the Positively Worded Items in the CES-D and Correlations of the Positive Affect (PA) Factor with 3 Depression Factors from the CES-D

CES-D Positively Worded Items	**Standardized Factor Loadings**						
	Time 1	**Time 2**	**Time 3**	**Time 4**	**Time 5**	**Time 6**	**Time 7**
I enjoyed life	.62	.42	.75	.61	.66	.67	.61
I was happy	.58	.73	.73	.79	.81	.77	.73
I felt hopeful about the future	.51	.59	.60	.57	.62	.67	.67
I felt I was just as good as other people	.17	.52	.57	.45	.42	.63	.50
Correlation of PA with Depression							
Positive Affect, Depression 1	−.75	−.56	−.67	−.66	−.67	−.70	−.77
Positive Affect, Depression 2	−.50	−.33	−.52	−.50	−.41	−.43	−.48
Positive Affect, Depression 3	−.71	−.56	−.68	−.66	−.58	−.69	−.87

Note: All standardized factor loadings and correlations were significant at the .001 alpha level.

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Table 2.

Correlation Matrix (with Variances in Diagonal) of Growth Factors in Bivariate Latent Growth Curve (LGC) Models of Positive Affect (PA), 3MS Scores (3M), and Verbal Memory (VM)

	Bivariate LGC of PA and 3M				
	PA_0	PA_1	$3M_0$	$3M_1$	$3M_2$
PA_0	0.103^{**}	--	--	--	--
PA_1	−.138	0.002^{**}	--	--	--
$3M_0$	$.623^{**}$	.124	0.515^{**}	--	--
$3M_1$	.067	−.068	-0.175^{+}	0.024^{**}	--
$3M_2$	.058	$.435^{*}$	$.451^{**}$	−.231	0.012^{**}
	Bivariate LGC of PA and VM				
	PA_0	PA_1	VM_0	VM_1	VM_2
PA_0	0.101^{**}	--	--	--	--
PA_1	−.193	0.003^{**}	--	--	--
VM_0	$.444^{**}$	.095	118.328^{**}	--	--
VM_1	−.103	.059	−.107	10.548^{**}	
VM_2	−.041	$.462^{**}$	$.255^{*}$	−.237	4.152^{**}

Note:

$^{**}p < .001$,

$^{*}p < .01$,

$^{+}p = .046$.

PA_0 = level of positive affect at 1st measurement occasion. PA_1 = rate of change in positive affect across all waves of assessment. $3M_0/VM_0$ = level of 3MS/VM at 3rd measurement occasion. $3M_1/VM_1$ = rate of change in 3MS/VM between 1st and 3rd measurement occasion. $3M_2/VM_2$ = rate of change in 3MS/VM between 3rd and 7th waves of assessment.