

Neural Reward Anticipation Moderates Longitudinal Relation between Parents' Familism Values and Latinx American Youth's School Disengagement

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Abstract

■ Parents' familism values predict a variety of Latinx American youth's academic adjustment. However, it is unclear how cultural values such as familism interact with youth's brain development, which is sensitive to sociocultural input, to shape their academic adjustment. Using a sample of 1916 Latinx American youth (mean age = 9.90 years, $SD = .63$ years; 50% girls) and their primary caregivers (mean age = 38.43 years, $SD = 6.81$ years; 90% mothers) from the Adolescent Brain Cognitive Development Study, this study examined the longitudinal relation between parents' familism values and youth's school disengagement, as well as the moderating role

of youth's neural sensitivity to personal reward. Parents' familism values predicted youth's decreased school disengagement 1 year later, adjusting for their baseline school disengagement and demographic covariates. Notably, this association was more salient among youth who showed lower (vs. higher) neural activation in the ventral striatum and the lateral OFC during the anticipation of a personal reward. These findings underscore the protective role of familism for Latinx American youth, highlighting the necessity of developing culturally informed interventions that take into consideration a youth's brain development. ■

INTRODUCTION

A growing number of studies have highlighted that culture can serve as an important protective factor for the development of minority children and adolescents (Cahill, Updegraff, Causadias, & Korous, 2021; Germán, Gonzales, & Dumka, 2009). This topic is highly relevant for Latinx American families, given that they make up one of the largest ethnic minority groups in the United States (Taylor, Larsen-Rife, Conger, & Widaman, 2012). *Familism*, which refers to one's attachment and identification with their family, is a particularly salient cultural construct among Latinx American families (Stein et al., 2014; Knight et al., 2010). Importantly, prior research has shown that higher levels of parents' familism values (e.g., sense of family obligation) are related to Latinx American youth's better academic adjustment (e.g., school attachment, educational aspirations, and academic achievement; Yan, Hou, Shen, & Kim, 2022; Taylor et al., 2012). In addition, given that the adolescent brain is sensitive to sociocultural input (e.g., Blakemore & Mills, 2014), it is crucial to take a closer look at how cultural values and neural systems interact to shape academic adjustment. Therefore, the present study aims to examine the longitudinal effects of parents' familism values on Latinx American youth's

school disengagement, with specific attention to the moderating role of youth's neural sensitivity to personal reward.

Parents' Familism Values and Latinx American Youth's School Disengagement

Parents' cultural values may influence their children's developmental outcomes, including academic adjustment, through cultural socialization processes (Hernández & Bámaca-Colbert, 2016). As one of the core cultural values within Latinx American families, familism values include a set of beliefs that reflect perceiving family as a primary source of support and emotional closeness (i.e., family support), having feelings of obligation to family (i.e., family obligation), and prioritizing family above individual needs when making decisions (i.e., family as referent; Stein et al., 2014; Knight et al., 2010). Strong familism values may promote one's desires and behaviors to make contributions to the family (Cahill et al., 2021). Latinx American parents who emphasize familism values may show greater commitment to their families and involvement in their parenting practices, which may engender both emotional and instrumental support (e.g., encouragement for children in times of setbacks; practical help when children have learning problems) for their children in the academic domain (Germán et al., 2009). Moreover, youth who have internalized their parents' familism values may be more

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motivated to work hard in school to meet their parents' expectations, honor their parents' investment, and accumulate resources to fulfill family obligations in the future (Dumka, Gonzales, Bonds, & Millsap, 2009). Indeed, prior empirical studies have demonstrated the positive associations between parents' familism values and youth's academic performance (e.g., grades; Yan et al., 2022; Valenzuela & Dornbusch, 1994). However, little research has focused on the motivational aspects of academic adjustment (e.g., effort put in school, motivation to do well), especially using a longitudinal design. Only one study revealed an indirect pathway that Mexican American parents' familism values were associated with fewer interparental conflicts, which, subsequently, were associated with youth's stronger attachment to school 1 year later (Taylor et al., 2012). Therefore, it is important to employ a longitudinal approach to examine the direct link between parents' familism values and Latinx American youths' school disengagement over time.

The Moderating Role of Neural Reactivity to Personal Reward

Given that adolescence is a developmental phase marked by significant neural changes (Casey, Jones, & Hare, 2008), it is important to take the developing brain into consideration when examining the role of familism values in Latinx American youth's academic adjustment. Theories on neurobiological susceptibility suggest that individual differences in brain development may moderate the effects of social contexts (e.g., cultural and parental contexts) on youth's psychological, behavioral, and academic development (Guyer, 2020; Schriber & Guyer, 2016; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2011; Belsky, Bakermans-Kranenburg, & Van Ijzendoorn, 2007). In this case, Latinx American youth may show different susceptibility to the parents' familism values depending on their brain development. During early adolescence, a particularly important change in youth's developing brain is their heightened neural reward reactivity, which contributes to their enhanced novelty and incentive-seeking behaviors (Crone, van Duijvenvoorde, & Peper, 2016; Van Duijvenvoorde, Peters, Braams, & Crone, 2016). Specifically, a brain region that is central to reward processing is the ventral striatum (VS), which is a subcortical region that processes reward-related stimuli and reward prediction errors (Telzer, 2016; Daniel & Pollmann, 2014; Pagnoni, Zink, Montague, & Berns, 2002).

Neural reactivity to personal reward may moderate the link between parents' familism values and youth's school disengagement because of the fit between brain development and cultural environment. When comparing personal and family reward (i.e., money for self vs. money for family), Latinx American youth show lower VS activation to personal reward than their European American counterparts (Telzer, Masten, Berkman, Lieberman, & Fuligni, 2010). It is possible that such lower levels of VS

activation to personal reward may result from Latinx cultural orientations of valuing family over personal needs. Therefore, Latinx American youth who show lower neural reactivity to personal reward may be more receptive to the aligned familism values, thereby benefiting more from the positive influence of parents' familism values on their academic adjustment. In contrast, youth with higher neural reactivity to personal reward may be less receptive to familism's emphasis on others, and thus they may be less likely to be influenced by their parents' values.

Moreover, heightened reactivity to monetary reward may reflect youth's worse relationships with parents, which is key for the transmission of cultural values. Past research found that worse parent-child relationships (e.g., decreased disclosure and increased conflict) are associated with youth's increased VS response to reward (Qu, Galvan, Fuligni, Lieberman, & Telzer, 2015; Casement et al., 2014). Youth with worse relationships with parents may experience less positive feedback from their parents, and thus they may seek rewards outside the family such as monetary reward to compensate for the lack of social rewards at home (Qu et al., 2015). Given that worse parent-child relationships hinder parents' socialization of cultural values (Tsai, Telzer, Gonzales, & Fuligni, 2015), Latinx American youth who are highly attuned to seeking out monetary reward may be less receptive to their parents' socialization of familism values. On the other hand, low neural reactivity to monetary reward may reflect youth's better relationships with parents (Qu et al., 2015), which helps youth internalize parents' familism values. Taken together, neural reactivity to monetary reward may be a marker of susceptibility in the influence of parents' familism values on Latinx American youth's engagement in school.

The Present Study

The present study investigated the longitudinal effect of parents' familism values on Latinx American youth's school disengagement, with attention to the moderating role of youth's neural sensitivity to personal reward. The research aims were preregistered as a non-peer-reviewed preregistration (https://aspredicted.org/D3B_2Y6). Guided by prior research, this study aimed to examine the following hypotheses. First, it was hypothesized that parents' familism values (i.e., a latent variable indicated by family support, family obligation, and family as referent) may predict Latinx American youth's decreased school disengagement 1 year later, after controlling for youth's school disengagement at baseline and demographic covariates. Second, it was hypothesized that the longitudinal association between parents' familism values and Latinx American youth's school disengagement may be moderated by youth's neural sensitivity to personal reward. Specifically, parents' familism values may play a larger role in youth's school disengagement over time among youth who show lower neural sensitivity to personal reward,

which is indicated by lower VS activity during reward processing in the monetary incentive delay (MID) task. In contrast, parents' familism values may have less impact on youth's school disengagement over time among youth who show heightened VS activation to personal reward in the MID task.

METHODS

Participants

Data were obtained from baseline (T1) and 1-year follow-up (T2) of the Adolescent Brain Cognitive Development (ABCD) study (data release 4.0). All the data included in the current study are available on the NIMH Data Archive (<https://nda.nih.gov/abcd>) upon data access request. Among the full Latinx American sample of 2411 youth at T1, 1916 Latinx American youth (mean age = 9.90 years, $SD = .63$ years; 50% girls) and their primary caregivers (mean age = 38.43 years, $SD = 6.81$ years; 90% mothers) were included in the analyses. The current research included participants based on the inclusion criteria provided by the ABCD team (i.e., participants with variable *imgincl_mid_include* = 1), which are the recommended quality control criteria of the MID task in ABCD data release note 4.0 (for detailed criteria, see ABCD Human Subjects Study, 2021).

Measures

Parents' Familism Values

At T1, parents' familism values were assessed using the Mexican American Cultural Values Scale (Knight et al., 2010). This measure was developed with Mexican American parents and youth, and has shown satisfactory reliability and validity (Knight et al., 2010). Although the Mexican American Cultural Values Scale was initially developed to evaluate cultural values that are commonly associated with Mexican American families, it has also been widely used among more general Latinx American samples (e.g., Walker, Cuervo, & Venta, 2022; Calzada, Roche, White, Partovi, & Little, 2020; for a review, see Cahill et al., 2021). The familism values scale includes family support (six items; e.g., "It is important for family members to show their love and affection to one another"), family obligation (five items; e.g., "If a relative is having a hard time financially, one should help them out if possible"), and family as referent (five items; e.g., "A person should always think about their family when making important decisions"). Parents rated how much they believed each item on a 5-point Likert scale (1 = *not at all* to 5 = *completely*). This measure showed good internal consistency, with McDonald's omega (ω) = .80 for family support, .73 for family obligation, and .78 for family as referent. Following prior research on familism values (e.g., Knight, Carlo, Mahrer, & Davis, 2016), family support, family obligation, and family as referent were used as three indicators of a latent construct of parents' familism values. All three

indicators loaded significantly on the latent familism variable with the factor loadings ranging from .75 to .87.

Youth's School Disengagement

Youth's school disengagement was measured at baseline (T1) and 1 year later (T2) using the Inventory for School Risk and Protective Factors from the PhenX Toolkit (Zucker et al., 2018). The school disengagement score was measured by three items (i.e., "In general, I like school a lot," "Usually, school bores me," and "Getting good grades is not so important to me") with a 4-point Likert scale (1 = *NO!*; 2 = *no*; 3 = *yes*; 4 = *YES!*). The score of the first item was reversed, and then the average was taken across all items, with higher scores representing youth's greater disengagement from school. This measure showed acceptable internal consistency, with McDonald's omega (ω) = .68 at T1 and .67 at T2. Additional details on the School Risk and Protective Factors inventory are described elsewhere (Zucker et al., 2018).

Demographic Covariates

In line with prior research using the ABCD data (e.g., Barch et al., 2021; Karcher, Schiffman, & Barch, 2021; Lees et al., 2021), the current study included youth's age, biological sex, parents' educational attainment, and household financial adversity as demographic covariates. Each of these covariates was found to be associated with youth's school adjustment (Brass, McKellar, North, & Ryan, 2019; Caro, McDonald, & Willms, 2009; Sánchez, Colón, & Esparza, 2005). Youth biological sex was coded into 0 = *male* and 1 = *female*. Parents' educational attainment was the highest educational attainment, ranging from 1 = *less than a high school diploma* to 5 = *postgraduate degree*. Household financial adversity was assessed using the Parent-Reported Financial Adversity Questionnaire (Diemer, Mistry, Wadsworth, López, & Reimers, 2013), which is the sum score on experiences of financial difficulties in the past 12 months (seven items, 0 = *no* and 1 = *yes*, range = 0–7; e.g., "In the past 12 months, has there been a time when you and your immediate family didn't pay the full amount of the rent or mortgage because you could not afford it?"). Given that the current study focused on Latinx American parents' familism values, parents' gender and nativity were also included (Knight et al., 2011, 2016). Parents' gender was coded into 0 = *male*, 1 = *female*. Parents' nativity was coded into 0 = *born in the United States*, 1 = *born outside of the United States*.

The MID Task

In the ABCD study, the MID task was used to measure specific domains of reward processing, including the anticipation and receipt of rewards and losses, as well as trial-by-trial motivation in speeded responses to win or avoid loss (Casey et al., 2018; Knutson, Westdorp, Kaiser,

& Hommer, 2000). The MID task is widely considered to be a robust activator of the VS and OFC; furthermore, it has demonstrated validity as a probe for reward processing (Casey et al., 2018; Knutson et al., 2000).

The MID task consisted of five trials (win \$.20, win \$5, lose \$.20, lose \$5, \$0 = no money at stake), and each trial began with an incentive cue informing participants that there is either no money at risk (neutral trial), a chance to gain money (reward trial), or a chance to lose money (loss trial; Casey et al., 2018). After that, participants quickly reacted to a target while being titrated to ensure roughly 60% accuracy. Participants received positive feedback (earn money or prevent losing money) if they reacted promptly; otherwise, they received negative feedback (do not win money or lose money). The MID task had 40 reward trials, 40 loss trials, and 20 neutral trials distributed equally throughout two fMRI scans. On average, participants gained \$21, and all participants were given a minimum of \$1 to maintain motivation throughout the entire scan protocol (Casey et al., 2018).

fMRI Data Acquisition and Preprocessing

MRI scanners (3 T, Siemens Prisma or GE MR750) were used for data collection across the 21 sites. Study site was included as a random effect in all inferential analyses to ensure that any explained variance was not confounded by scanner-specific variance. Participants underwent a T1-weighted anatomical MRI sequence with the following parameters: matrix = 256×256 , slices = 176 (Siemens), 208 (GE), field of view = 256×256 , resolution = 1-mm isotropic space, repetition time = 2500 msec (Siemens, GE), echo time = 2.88 msec (Siemens), flip angle = 8. In addition, two multiband fMRI sequences were utilized for the MID task: matrix = 90×90 , slices = 60, field of view = 216×216 , resolution = 2.4-mm isotropic space, repetition time = 800 msec, echo time = 30 msec, flip angle = 52, multiband factor = 6 (Casey et al., 2018). Before the MRI scanning sessions, children practiced motion compliance in a simulated MRI environment with motion-capture devices that provided feedback to the child. The T1-weighted sequence involved the collection of brief head-tracking images that were included into the main sequence to correct for potential head motion (Hagler et al., 2019). Framewise Integrated Real-Time MRI Monitoring software (Dosenbach et al., 2017) was also used to track participants' head motion in real time for fMRI data collected at all of the study sites that used Siemens scanners. This software allowed scanner operators to correct motion by giving participants verbal feedback along with collecting additional data (Hagler et al., 2019). Standard adult-size multichannel head coils were used for all scans because using custom age-appropriate head coils could potentially interfere with future longitudinal analyses of the ABCD data. E-Prime Professional software (Version 2.0; Schneider, Eschman, & Zuccolotto, 2012) was used to deliver the stimuli for

the MID task, and Current Designs button boxes were used to record responses (Science Plus Group).

MRI data in the ABCD study were processed and analyzed by members of the ABCD Data Analysis and Informatics Center. The ABCD team utilized the same validated methods that have been commonly used in comparable large-scale studies (Hagler et al., 2019; Casey et al., 2018). AFNI's *3dvolreg* (Cox, 1996) was used to correct for head motion by registering each frame to the first, as well as providing estimates of head motion time courses. Distortions were also addressed by reversing the polarity of the signal (Holland, Kuperman, & Dale, 2010). The displacement field was computed using several spin-echo calibration scans and then adjusted using estimates for between-scans head motion. It was then applied to the sequence of gradient-echo images to prevent signal "drop-out" caused by within-voxel field gradients in gradient-echo images. The distortions caused by gradient nonlinearities were then removed from the images (Jovicich et al., 2006). Reference scans were chosen for each participant to help correct for between-scans motion. The initial frame from each scan was rigidly aligned with the first frame of the reference scan, and automated registration between spin-echo, calibration scans, and structural images was carried out using mutual information with coarse pre-alignment (Hagler et al., 2019). To supplement the rigid-body transformation between fMRI and pictures, a registration matrix was used. The resulting fMRI pictures have a 2.4-mm isotropic resolution and remain in "native space" (Hagler et al., 2019). The ABCD team applied several steps of quality control to remove participants with poor imaging quality because of head motion. First, participants were excluded according to automated quality control metrics of mean motion (average framewise displacement); the number of seconds with framewise displacements less than 0.2, 0.3, or 0.4 mm (Power, Barnes, Snyder, Schlaggar, & Petersen, 2012); and temporal signal-to-noise ratio (Triantafyllou et al., 2005). Second, the ABCD team manually inspected for signs of artifacts and poor image quality including brain cutoff because of the participant motion outside prescribed slices and T1w and T2w motion artifact (e.g., blurring and ghosting). Third, the ABCD team manually reviewed FreeSurfer cortical surface reconstruction (Fischl, 2012) to gauge the severity of artifact or processing problem. For more details on cutoffs, see the NDA 4.0 MRI Quality Control Recommended Inclusion file in ABCD data release note 4.0 (ABCD Human Subjects Study, 2021).

Reward anticipation against neutral, loss anticipation versus neutral, reward positive versus negative feedback, and loss positive versus negative feedback were the four primary fMRI contrasts used on the MID task. Using FreeSurfer' automated brain segmentation (aseg) atlas (Fischl, 2012), the ABCD researchers were able to segment participant-specific regions of interest to calculate mean beta weights across all four key contrasts. During reward processing, varying levels of activation in the VS and OFC

are thought to represent one's sensitivity to reward (Casey et al., 2018; O'Doherty, 2004). Changes in adolescents' reactivity within these brain regions could also signify the restructuring of reward and motivation circuitry (Bretzke et al., 2021; Fair et al., 2009). Therefore, the current study employed a ROI approach by examining VS and OFC activity during reward anticipation and reward receipt. Activity during reward anticipation was measured by the contrast between the anticipation of a reward and the anticipation of a neutral outcome. Activity during reward receipt was measured by the contrast between positive reward feedback (i.e., winning the money) and negative reward feedback (i.e., not winning the money). Estimates of VS and OFC activity related to each of these contrasts were used in the subsequent analyses.

Overview of the Analyses

Descriptive statistics and bivariate correlations were conducted before the primary analyses. To test the hypotheses, two sets of analyses were performed in the context of structural equation modeling using Mplus 8.9. In all models, youth's age and biological sex, parents' gender, nativity, highest educational attainment, and household financial adversity were included as demographic covariates. The inclusion of demographic covariates improved the model fit. Chi-square test of model fit indicated that the model with demographic covariates ($\chi^2 = 23.61$, $df = 5$, $p = .009$) showed better model fit than the model without demographic covariates ($\chi^2 = 96.81$, $df = 16$, $p < .001$). The TYPE = COMPLEX command and the STRATIFICATION = SITE ID command in Mplus were used to account for the clustering effect derived from the nested structure of the data (i.e., siblings nested within families and the multisite design) following previous studies (Chaku, Barry, Fowle, & Hoyt, 2022). The attrition rate from T1 to T2 was approximately 8%. Compared with those who only participated in the first wave, participants who participated in both waves showed higher parents' educational attainment ($t = 2.79$; $p = .005$) and lower household financial adversity ($t = -1.98$; $p = .05$). Results of the Little's test ($\chi^2 = 129.48$, $p = .006$) suggested that missing cases were not missing completely at random (Little, 1988). Full information maximum likelihood estimation was used to handle missing data.

Following the preregistration (https://aspredicted.org/D3B_2Y6), the first set of analyses examined the main effect of parents' familism values on Latinx American youth's school disengagement over time. Specifically, youth's school disengagement at T2 was predicted by parents' familism values at T1, adjusting for youth's school disengagement at T1 and demographic covariates. Parents' familism values were specified as a latent variable with three indicators (i.e., family support, family obligations, and family as referent). The model fit was evaluated using the recommended cutoff point of three routinely used goodness-of-fit indexes, which are the comparative

fit index (CFI) $> .90$, the root-mean-square error of approximation (RMSEA) $< .08$, and the standardized root-mean-square residual (SRMR) $< .06$ (Byrne, 2011). Again, following the preregistered analytic plan, the second set of analyses tested the moderating role of youth's VS activation to personal reward in the longitudinal link between parents' familism values and youth's school disengagement. Youth's school disengagement at T2 was predicted by parents' familism values at T1, youth's neural reward sensitivity at T1, and parents' familism values $\times$ youth's neural reward sensitivity at T1, controlling for youth's school disengagement at T1 and demographic covariates. VS activity during reward anticipation and VS activity during reward receipt were examined in two separate models. The latent moderated structural equations (LMS) approach was adopted to generate the latent interaction term between a latent variable (i.e., familism values) and an observed variable (i.e., neural reward sensitivity) using the XWITH command in Mplus (Maslowsky, Jager, & Hemken, 2015). The conventional model fit indexes (i.e., CFI, RMSEA, and SRMR) are not available in LMS models involving latent interaction terms. Following prior research (e.g., Zhou, Qu, & Li, 2022), the fit indexes before entering the latent interaction term were used to evaluate the model fit of LMS models. Finally, interaction plots were plotted using the interActive application (McCabe, Kim, & King, 2018), which was created using the ggplot2 graphics package (Wickham, 2009). Given that latent interaction terms were not supported in the ggplot2 graphics package, parents' familism values were computed by taking the mean of its three indicators (i.e., family support, family obligations, and family as referent) for interaction plots.

In addition to the preregistration, the exploratory analyses also examined OFC activity during reward processing (i.e., lateral and medial OFC activity during reward anticipation and receipt) as a potential moderator in the longitudinal link between parents' familism values and youth's school disengagement. Finally, as sensitivity analyses, we rerun all the models without demographic variables to ensure that all the results were not influenced by the inclusion of the covariates.

RESULTS

Descriptive Statistics and Correlations

Table 1 shows descriptive statistics and correlations between key variables examined in the current study. The three indicators of parents' familism values—family support, family obligation, and family as referent—were highly correlated with each other ($r_s > .62$, $p_s < .001$). Parents' familism values were not correlated with youth's school disengagement at T1 but were generally associated with lower school disengagement among youth at T2 (family support: $r = -.06$, $p = .009$; family obligation: $r = -.03$, $p = .16$; family as referent: $r = -.05$, $p = .06$). Youth's neural activity during reward processing was generally not correlated with

Table 1. Descriptive Statistics and Correlations among Key Variables

	1	2	3	4	5	6	7	8	9	10	11
1. T1 family support	–										
2. T1 family obligation	.65***	–									
3. T1 family as referent	.62***	.73***	–								
4. T1 VS reward anticipation	–.06*	–.02	–.02	–							
5. T1 lateral OFC reward anticipation	–.04	–.02	.00	.45***	–						
6. T1 medial OFC reward anticipation	–.01	–.00	.01	.39***	.71***	–					
7. T1 VS reward receipt	–.01	–.03	.00	.02	.03	.02	–				
8. T1 lateral OFC reward receipt	.02	–.03	.01	.05*	.09***	.06**	.48***	–			
9. T1 medial OFC reward receipt	–.01	–.05*	–.01	.03	.09***	.08***	.48***	.72***	–		
10. T1 school disengagement	.02	.02	–.02	.02	.01	.05*	–.00	.05*	.03	–	
11. T2 school disengagement	–.05*	–.02	–.04	.01	.01	.04	.03	.06*	.05	.48***	–
<i>Mean</i>	4.37	3.83	3.63	.06	–.01	–.03	.14	.01	.08	1.81	1.88
<i>SD</i>	.57	.69	.79	.26	.27	.38	.31	.38	.52	.72	.69

* $p < .05$.** $p < .01$.*** $p < .001$.

school disengagement, except some positive correlations between lateral OFC activity during reward receipt and school disengagement ($r_s > .04$, $p_s < .04$). Girls reported lower school disengagement at both T1 and T2 ($r_s < -.10$, $p_s < .001$); household financial adversity was positively correlated with youth's school disengagement at both T1 and T2 ($r_s > .06$, $p_s < .01$); youth's age, parents' gender, nativity, and educational attainment were not correlated with youth's school disengagement at T1 or T2.

Main Effect of Parents' Familism Values on Youth's School Disengagement

The main effect model examined the longitudinal relation between parents' familism values and Latinx American youth's school disengagement. The data fit the model well, CFI = .97, RMSEA = .05, SRMR = .02. Results showed that parents' familism values significantly predicted youth's decreased school disengagement 1 year later over and above their baseline school disengagement and other demographic covariates, $\beta = -.06$, $p = .008$.

The Moderating Role of VS Activation to Personal Reward

Two latent moderation models were estimated using the LMS approach to examine the moderating role of youth's

VS activation to personal reward in the link between parents' familism values and youth's school disengagement. VS activity during reward anticipation and VS activity during reward receipt were examined in separate models. Both models before entering the latent interaction term showed good fit indexes, CFIs $> .97$, RMSEAs $< .05$, SRMRs $< .02$.

The latent moderation model with youth's VS activity during reward anticipation as the moderator showed a significant interaction effect between youth's neural activity and parents' familism values on youth's school disengagement 1 year later ($\beta = .06$, $p = .02$; Model 1 of Table 2). The moderating role of VS activity during reward anticipation remained significant after adjusting for false discovery rate ($p = .04$). However, VS activity during reward receipt did not moderate the link between parents' familism values and youth's school disengagement ($\beta = .02$, $p = .23$).

The moderating role of youth's VS activity during reward anticipation was plotted using the interActive application (McCabe et al., 2018). As shown in Figure 1A, parents' familism values were associated with youth's decreased school disengagement among youth with average (0 *SD* from the mean), low (-1 *SD* from the mean), and lower (-2 *SDs* from the mean) levels of VS activity during reward anticipation, but not among youth with high ($+1$ *SD* from the mean) and higher ($+2$ *SDs* from the mean) levels of VS activity during reward anticipation. As

Table 2. Moderation Effects of Youth's Neural Activation to Anticipation of Personal Reward on the Link between Parents' Familism Values and Youth's School Disengagement

	Predicting Youth's School Disengagement at T2								
	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β	<i>b</i>	<i>SE</i>	β
	Model 1: VS Reward Anticipation			Model 2: Lateral OFC Reward Anticipation			Model 3: Medial OFC Reward Anticipation		
Youth's school disengagement at T1	.45	.02	.46***	.45	.02	.46***	.44	.02	.46***
Parents' familism values at T1	-.10	.04	-.06*	-.10	.04	-.06*	-.10	.04	-.06*
Youth's neural activation at T1	.00	.06	.00	.01	.06	.00	.02	.04	.01
Familism values $\times$ VS activation at T1	.37	.16	.06*	.36	.17	.06*	.16	.11	.04
Covariates									
Youth's age	.02	.02	.02	.02	.02	.02	.02	.02	.02
Youth's gender	-.14	.03	-.10***	-.13	.03	-.10***	-.14	.03	-.10***
Parents' gender	-.06	.05	-.02	-.06	.05	-.02	-.06	.05	-.03
Parents' nativity	-.02	.03	.01	-.02	.03	.01	-.02	.03	.01
Parents' education	-.02	.01	-.04	-.02	.01	-.04	-.02	.01	-.04
Household financial adversity	.03	.01	.04	.03	.01	.04	.03	.01	.04

Youth's biological sex at birth was coded as 0 (*male*) and 1 (*female*). Parents' gender was coded as 0 (*male*) and 1 (*female*). Parents' nativity was coded as 0 (*born in the United States*) and 1 (*born outside of the United States*). Parents' education was coded from 1 (*no high school degree*) to 5 (*more than bachelor's degree*). Household financial adversity ranged from 0 (*no adversity*) to 7 (*high adversity*).

* $p < .05$.

*** $p < .001$.

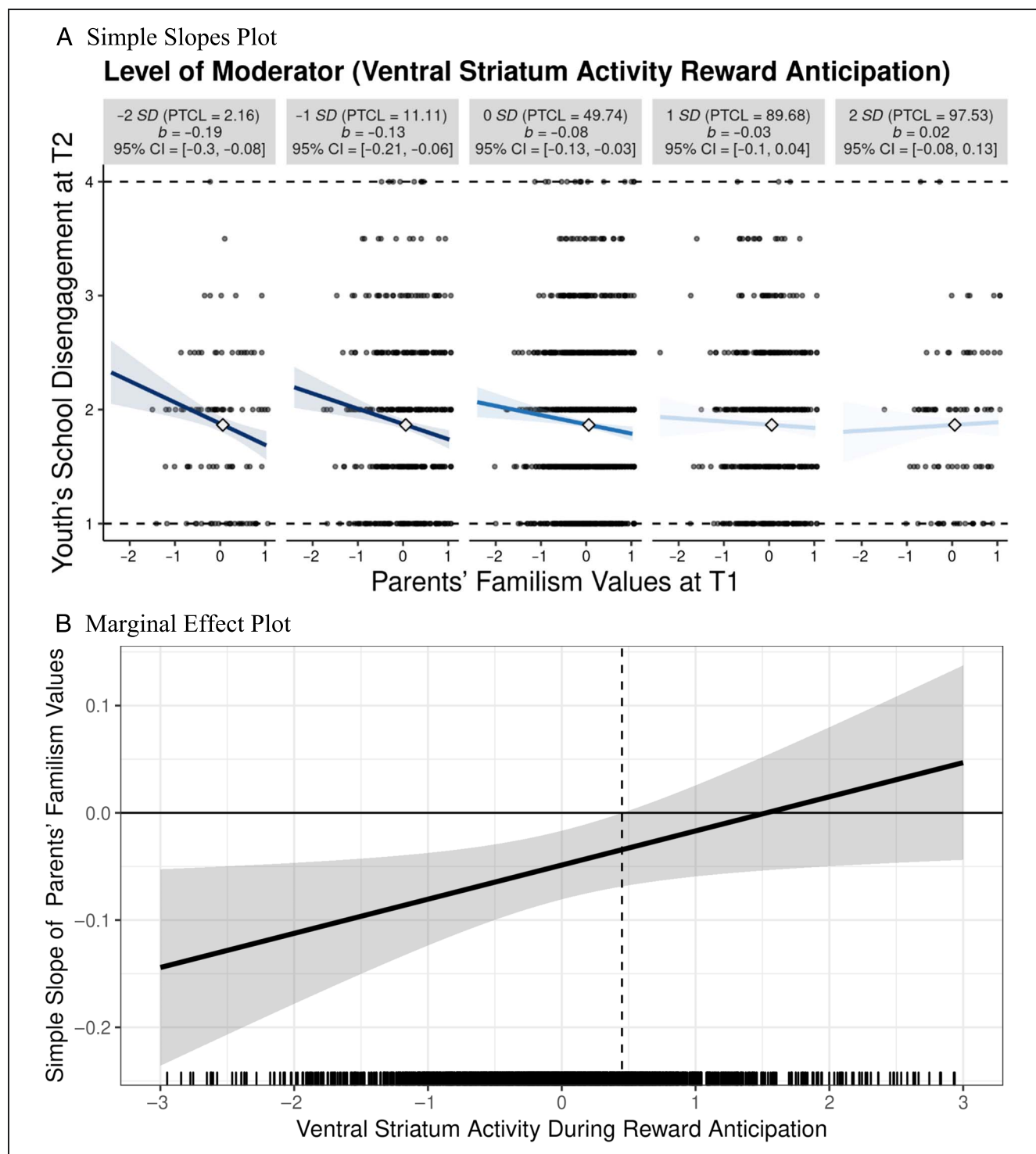


Figure 1. The longitudinal association between parents' familism values and youth's later school disengagement was moderated by youth's VS activation during reward anticipation. (A) The association between parents' familism values and youth's later school disengagement across different levels VS activation during reward anticipation. (B) Highlight of where the simple slope starts to be significant. Baseline school engagement and demographic covariates were included in the model.

shown in Figure 1B, the simple slope of parents' familism values on youth's school disengagement was significant and negative when youth's VS activity during reward anticipation is 0.45 SD away from the mean or further. During reward anticipation, 71.3% of observations in youth's VS activity are within this region.

Exploratory Analysis of the Moderating Role of OFC Activation to Personal Reward

As exploratory analysis, similar latent moderation models were estimated to examine the moderating role of youth's OFC activation to personal reward in the link between

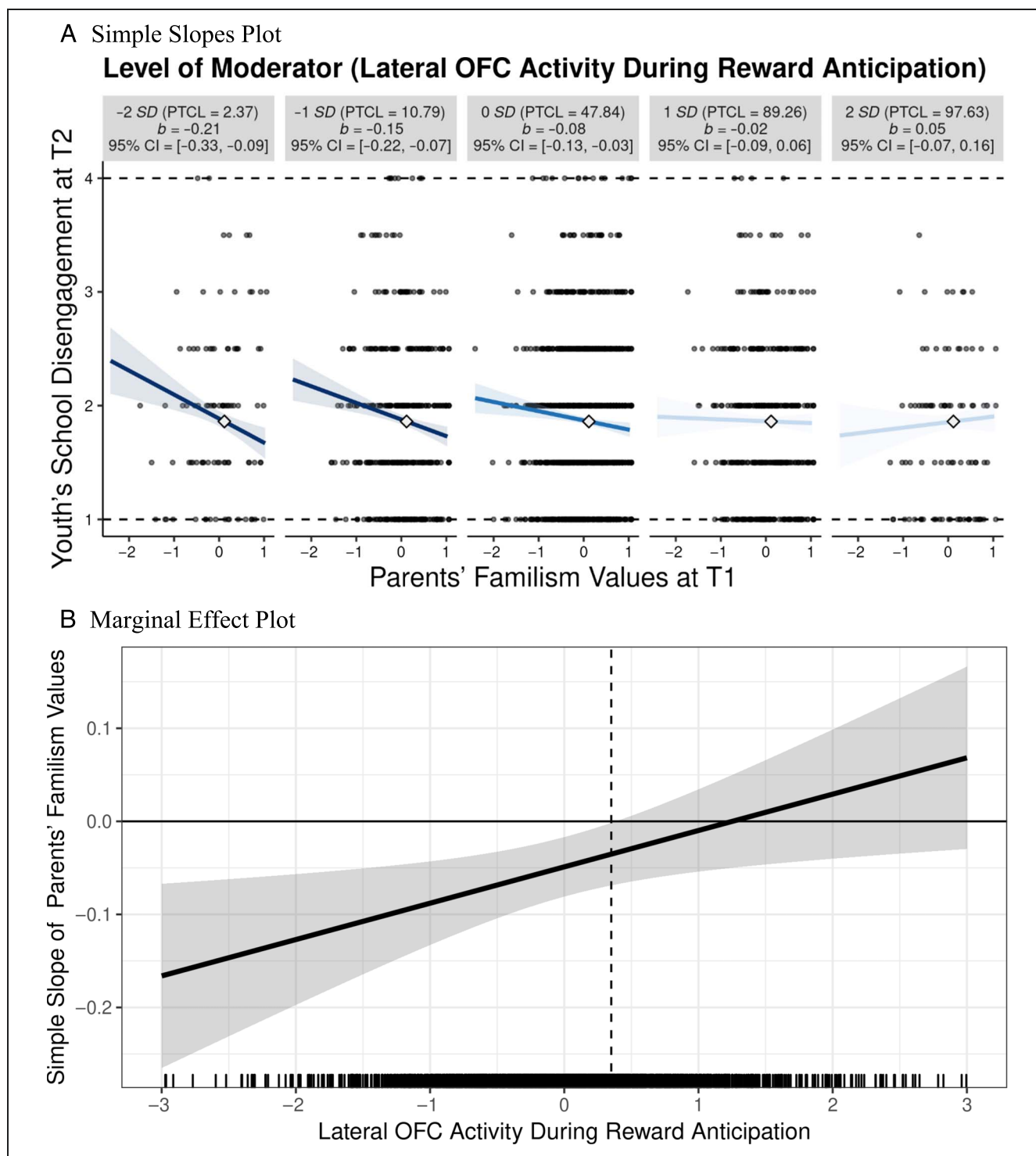


Figure 2. The longitudinal association between parents' familism values and youth's later school disengagement was moderated by youth's lateral OFC activation during reward anticipation. (A) The association between parents' familism values and youth's later school disengagement across different levels lateral OFC activation during reward anticipation. (B) Highlight of where the simple slope starts to be significant. Baseline school engagement and demographic covariates were included in the model.

parents' familism values and youth's school disengagement. Results showed that there was a significant interaction effect between youth's lateral OFC activity during reward anticipation and parents' familism values on youth's school disengagement ($\beta = .06, p = .03$; Model 2 of Table 2). Given its exploratory nature, the moderating

role of lateral OFC activity during reward anticipation was not corrected for multiple comparisons, and thus, the result should be interpreted with more caution. Albeit showing the moderating effect in the same direction, the interaction effect between youth's medial OFC activity during reward anticipation and parents' familism values on

youth's school disengagement was not significant ($\beta = .04, p = .14$; Model 3 of Table 2). Similarly, OFC activity during reward receipt did not moderate the link between parents' familism values and youth's school disengagement (lateral OFC: $\beta = -.01, p = .83$; medial OFC: $\beta = -.02, p = .42$).

The moderating role of youth's lateral OFC activity during reward anticipation was plotted using the *interActive* application (McCabe et al., 2018). As shown in Figure 2A, parents' familism values were associated with youth's decreased school disengagement among youth with average (0 *SD* from the mean), low (-1 *SD* from the mean), and lower (-2 *SDs* from the mean) levels of lateral OFC activity during reward anticipation, but not among youth with high ($+1$ *SD* from the mean) and higher ($+2$ *SDs* from the mean) levels of lateral OFC activity during reward anticipation. As shown in Figure 2B, the simple slope of parents' familism values on youth's school disengagement was significant and negative when youth's lateral OFC activity during reward anticipation is 0.35 *SD* away from the mean or further. During reward anticipation, 67.2% of observations in youth's lateral OFC activity are within this region.

Sensitivity Analyses

Finally, we conducted a set of sensitivity analyses to ensure that all the key results were not influenced by the inclusion of demographic covariates (i.e., youth's age, biological sex, parents' gender, nativity, educational attainment, and household financial adversity). To this end, all the main analyses were rerun without these covariates. There were no meaningful changes to the results. Parents' familism values predicted youth's decreased school disengagement over time, controlling for youth's baseline school disengagement ($\beta = -.06, p = .01$). Youth's VS activation during reward anticipation ($\beta = .06, p = .01$) but not during reward receipt ($\beta = .02, p = .39$) moderated the longitudinal link between parents' familism values and youth's school disengagement. Taken together, these sensitivity analyses ruled out potential demographic confounds that may drive the findings.

DISCUSSION

Researchers have previously demonstrated that the adolescent brain is sensitive to sociocultural influence (e.g., Blakemore & Mills, 2014). Although it has been established that cultural and social experiences influence adolescent brain development, it is less understood how cultural factors interact with neural processes to play a role in youth's developmental trajectories (Qu, Jorgensen, & Telzer, 2021). This is especially important when considering whether certain cultural values (i.e., familism) serve as important protective factors for the development of minority children and adolescents (Cahill et al., 2021; Park, Sasser, & Doane, 2021). Familism, which refers to one's

attachment and identification with their family, has been associated with Latinx American youth's academic adjustment (e.g., Taylor et al., 2012; Valenzuela & Dornbusch, 1994). Using a large-scale longitudinal sample from the ABCD study, the current research found that parents' familism values did, in fact, predict Latinx American youth's decreased school disengagement over a period of 1 year. Importantly, parents' familism values were more likely to predict decreased school disengagement specifically among youth who exhibited lower VS and lateral OFC activation during reward anticipation.

As expected, parents' familism values, which were indicated by family support, family obligation, and family as a referent, predicted Latinx American youth's lower school disengagement 1 year later, adjusting for their initial school disengagement. These results are in line with a large body of literature that has identified familism values as a protective and promotive factor for Latinx American youth who are facing heightened contextual risks and challenges (Cahill et al., 2021; Park et al., 2021), and provide empirical support for the positive impact of parents' familism values on youth's academic motivation over time. Parents' stronger endorsement of familism values may contribute to youth's greater academic motivation because these parents may be more likely to engage in youth's educational development (e.g., paying attention to their youth's academic performance, providing help when their youth are facing difficulties) and establish more supportive parent-child relationships (Taylor et al., 2012).

Moreover, familism values may promote youth's school engagement by providing them family-orientated motivation. This can be important for youth's academic development because, although youth understand the importance of academic work, they typically find it less enjoyable compared with other activities (Duckworth, Taxer, Eskreis-Winkler, Galla, & Gross, 2019; Bjork & Bjork, 2011). The more parents endorse familism values, the more they are willing to socialize such values to youth and promote youth's internalization of familism values (Knight et al., 2011). For school-aged children, working hard in school is a crucial part of the family obligation they need to fulfill (Stein et al., 2014; Fuligni & Pedersen, 2002). Therefore, youth who have internalized familism values may show greater academic motivation to achieve academic success as a way to fulfill their family obligation. It is worth noting that youth's decreased school disengagement does not necessarily guarantee their academic success. Despite a strong association between school engagement and academic achievement (Lei, Cui, & Zhou, 2018), there are many other factors that may alter this pathway to success (Saqr, López-Pernas, Helske, & Hrastinski, 2023). It is important for future research to incorporate academic achievement and other aspects of academic adjustment to expand the current understanding of how familism influences Latinx American youth's academic development.

Importantly, youth's VS and lateral OFC activation during reward anticipation moderated the longitudinal

associations between parents' familism values and youth's school disengagement. The effect sizes of the moderation effects ($\beta_s = .06$) are relatively large in comparison to previous articles on neurobiological susceptibility using the ABCD study data (e.g., Gunther, Petrie, Pérez-Edgar, & Geier, 2023; Yang et al., 2023; Liu, Oshri, Kogan, Wickrama, & Sweet, 2021). These findings extend prior empirical evidence showing that adolescents' ventral striatal and prefrontal activity may influence their psychological and academic adjustment (e.g., Telzer, 2016; Qu et al., 2015; Casey et al., 2008). Among those adolescents who exhibited low VS and lateral OFC activity during reward anticipation, parents' familism values were more likely to predict decreased school disengagement over a period of 1 year. Conversely, for adolescents who displayed heightened VS and lateral OFC activation, parents' familism values were not associated with any changes in school disengagement. Prior studies have highlighted the importance of the VS and OFC in reward anticipation (Liu, Hairston, Schrier, & Fan, 2011; O'Doherty, 2004). Whereas youth's heightened VS activity during reward anticipation suggest that they may show greater affective response to the prospect of personal reward (Knutson, Adams, Fong, & Hommer, 2001), heightened lateral OFC activity during reward anticipation suggest that youth may be more engaged in the evaluation of the prospect of personal reward (Sescousse, Redouté, & Dreher, 2010). Overall, youth with these heightened neural activities are likely to be more attuned to personal gain. Taken together, these results suggest that youth who are less responsive to personal reward may be more readily influenced by their parents' familism values. In other words, it is possible that youth who display decreased neural sensitivity during reward anticipation may be more likely to prioritize the needs of their family over their personal needs. This, in turn, may contribute to their improved motivation and engagement in school. In contrast, adolescents who are more likely to pursue personal rewards may not internalize their parents' familism values to the same degree.

However, youth's VS and lateral OFC activity during reward receipt did not moderate the link between parents' familism values and youth's school disengagement. Although both anticipation and receipt are essential to reward processing, reward anticipation emphasizes the processing of the prospect of reward, and reward receipt emphasizes the processing of reward-related results (Oldham et al., 2018). Prior research suggests that the neural responses during the anticipation and receipt of reward are distinctly different (Pornpattananangkul & Nusslock, 2015; Simon et al., 2015), and the developmental trajectories of anticipation and receipt also differ during adolescence (Hoogendam, Kahn, Hillegers, van Buuren, & Vink, 2013). Moreover, it is possible that the exhibited differences in neural activation during reward anticipation and receipt could be related to the design of the MID task. More specifically, the anticipation phase of the MID task is unique in that it involves a degree of uncertainty (i.e.,

whether the participant can win the reward), which is an important component of risk attitude (Peterman & Anderson, 1999). Prior research has indicated that youth who endorse familism values are less likely to engage in risk-taking behavior (Wheeler et al., 2017), which may explain why there was a stark contrast in youth's neural responses during both phases of the MID task. Nevertheless, the present findings do not provide a sufficient answer as to why reward anticipation and receipt may disparately influence the link between parents' familism values and youth's school disengagement. By utilizing additional measures, future studies can take a more detailed look at how both phases of reward processing independently contribute to cultural transmission.

The interactive roles of familism and neural reward anticipation support the notion that individual differences in youth's neurobiological development may be markers of differential susceptibility to environmental influences (Guyer, 2020; Schriber & Guyer, 2016). In line with the theory on differential susceptibility (Belsky et al., 2007), lower levels of neural sensitivity to personal reward may make youth more susceptible to the influence of parents' familism values, such that youth with lower reward anticipation would show developmental enhancement under high levels of parents' familism values and developmental vulnerability under low levels of parents' familism values. Ultimately, the current research demonstrates that parents' familism values can predict youth's academic motivation; however, the degree to which they do so may vary depending on adolescents' susceptibility to personal reward.

Theoretical and Practical Implications

From a theoretical standpoint, the present study draws upon a biopsychosocial perspective of adolescent development. Although there has been a vast interest in the protective role of familism in Latinx American youth's development (e.g., Cahill et al., 2021; Germán et al., 2009), few studies took a biological approach and, to our knowledge, none combined both biological and psychosocial approaches to understand academic development in this important community. By examining how sociocultural factors interact with neural processes, this work provides novel insights into Latinx American youth's academic development. Echoing the call for studying the role of culture in adolescent brain development (Qu et al., 2021), this study broadens existing knowledge of how cultural values interact with the developing brain. With regard to the practical implications, the protective role of familism in youth's academic adjustment points to the importance of developing culturally informed interventions for Latinx American youth. By highlighting the moderating role of neural reward during reward processing, varying levels of activation in the VS and OFC are thought to represent one's sensitivity to reward. During adolescence, changes in reactivity within these brain regions could

signify the restructuring of reward and motivation circuitry (Bretzke et al., 2021; Fair et al., 2009). The findings also helped lay the foundation for identifying groups of youth who may benefit more from promoting their parents' familism values. Ultimately, this work may have important implications for developing strengths-based policies and interventions that support minority youth's academic adjustment.

Limitations and Future Directions

The present study is constrained by several limitations that warrant further research moving forward. First, the current findings are correlational in nature, meaning that additional work will be needed to infer causality. Second, although the data used in this study were collected over the span of 1 year, additional time points may be needed if researchers wish to gain a clearer picture of how familism values become internalized over a longitudinal period. Third, although parents' familism values were of interest for the current study, future related studies may benefit from incorporating measures related to adolescents' familism values when analyzing interactions between familism and youth's reward sensitivity. Fourth, although the present study utilized a large sample, it is unclear whether these findings are generalizable to broader populations. Future work should aim to investigate whether these findings can be replicated in Latinx groups outside of the United States, as well as other racial or ethnic groups that adhere to a collectivist cultural orientation. Finally, the current study utilized the MID task to measure neural activity in response to personal reward, which did not provide a social context to emphasize the personal aspect of the reward. It is crucial for future research on youth's susceptibility to cultural environments to expand beyond the examination of general neural reward sensitivity. For example, future studies can examine a diverse range of neural reward sensitivity using tasks on social versus monetary reward (Lin, Adolphs, & Rangel, 2012), family versus personal reward (Telzer et al., 2010), and prosocial versus personal reward (Telzer et al., 2014). Providing a social context would help further clarify why neural reactivity to personal reward marks youth's susceptibility to cultural values.

Conclusion

The current study demonstrates that the VS and lateral OFC may be markers of neurobiological susceptibility to personal reward, which in turn act as moderators between parents' familism values and Latinx American youth's school disengagement over time. Specifically, for youth who showed low activation in the VS and lateral OFC when anticipating personal reward, parents' familism values were predictive of youth's decreased school disengagement 1 year later. In contrast, among youth who exhibited high neural sensitivity when anticipating personal reward, parents' familism values were not associated with youth's

school disengagement over time. Given that adolescents often exhibit more reward sensitivity than other age groups, it is crucial to investigate how brain networks involved in reward processing interact with various socio-cultural factors to engender specific developmental outcomes. Ultimately, the current findings highlight how differential reward susceptibility may disparately influence outcomes for minority adolescents. Such work may be useful for developing future policies and interventions that aim to promote positive youth development.

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Data Availability Statement

The preregistration for the current study can be accessed at https://aspredicted.org/D3B_2Y6. The data and materials of the ABCD study are publicly accessible at <https://nda.nih.gov/abcd/>. Requests for the code can be sent to the corresponding author.

Author Contributions

Varun Devakonda: Conceptualization; Writing—Original draft; Writing—Review & editing. Zexi Zhou: Conceptualization; Formal analysis; Software; Visualization; Writing—Original draft; Writing—Review & editing. Beiming Yang: Data curation; Formal analysis; Software; Writing—Review & editing. Yang Qu: Conceptualization; Funding acquisition; Methodology; Project administration; Resources; Supervision; Writing—Review & editing.

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Diversity in Citation Practices

Retrospective analysis of the citations in every article published in this journal from 2010 to 2021 reveals a persistent pattern of gender imbalance: Although the proportions of authorship teams (categorized by estimated gender identification of first author/last author) publishing in the *Journal of Cognitive Neuroscience* (JoCN) during this period were M(an)/M = .407, W(oman)/M = .32, M/W = .115, and W/W = .159, the comparable proportions for the articles that these authorship teams cited were M/M = .549, W/M = .257, M/W = .109, and W/W = .085 (Postle and Fulvio, JoCN, 34:1, pp. 1–3). Consequently, JoCN encourages all authors to consider gender balance explicitly when selecting which articles to cite and gives them the opportunity to report their article's gender citation balance. The authors of this paper report its proportions of citations by gender category to be: M/M = .450; W/M = .175; M/W = .100; W/W = .275.

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