# Perceived stress and cortisol reactivity among immigrants to the United States: The importance of bicultural identity integration

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ABSTRACT

Migration experiences are inherently stressful and may negatively affect the health of immigrants. Bicultural identity integration (BII), individuals' views of their multiple cultures as compatible and complementary, and their ability to easily integrate these cultures into their daily lives, has been linked with health outcomes. The main goal of the present study was to determine whether perceived stress and cortisol, a hormone of the HPA axis implicated in the biopsychological pathway linking stress and disease, are associated with BII. The sample consisted of 127 male and female, primarily Latino (68.3%) university and community college students (M = 20.4 yrs, SD = 2.1) who were either foreign-born or had at least one foreign-born parent. Regression analyses indicate that individuals scoring low on the cultural harmony subscale of the BII reported more perceived stress, overall model, $F(2,126) = 18.04$, $p < .001$, and had higher salivary cortisol levels following a standardized laboratory stressor (Trier Social Stress Test), as indicated by a more pronounced cortisol mean increase, $F(2,111) = 5.11$, $p = .01$, and a larger cortisol area under the curve with respect to ground, $F(2,108) = 5.85$, $p = .004$, controlling for neuroticism. Our findings link perceived stress and cortisol reactivity with the BII cultural harmony subscale, above and beyond the known effects of neuroticism, suggesting that this construct is important to consider in biopsychosocial studies of immigrant stress and health.

## 1. Introduction

Migration is a global phenomenon, and roughly 3.3 percent of the world's population are international migrants (United Nations, 2015). In the United States, a country of immigrants since its founding, the percentage of international migrants relative to the total population is much higher with an estimate of 13.3% (Camarota and Zeigler, 2016). International migration is stressful for most migrants. Even in the absence of significant stressors that may result from the harsh living conditions, war or other trauma that often precede or accompany the migration experience (Falconier et al., 2016; Kirmayer et al., 2011), the need to adapt to unfamiliar norms, values and the language of the host culture poses significant stressors (Berry, 1990). It is evident from decades of research that stress and disease are linked (Chrousos and Gold, 1992), and it would be intuitive to hypothesize that migrants have particularly poor health outcomes because of their significant stress exposure. However, many studies, in particular those among Latino immigrants to the United States, suggest that immigrants' mental and physical health is in fact better than the health of second and third

generation immigrants or that of members of the host society (Alegria et al., 2008; Ruiz et al., 2013).

Early theories of stress and health in immigrants posited that individuals who successfully assimilate to their host culture are less stressed, better psychologically adjusted and healthier than those who aim to integrate both cultures (Berry, 1990). Empirical findings testing this assumption, however, are mixed (Moyerman and Forman, 1992; Rogler et al., 1991). Whereas some studies suggest that negotiating two cultures is burdensome and may result in feelings of stress, isolation and identity confusion, other studies find that bicultural individuals are better adjusted because they have access to social support from both cultures, and have greater integrative complexity, intellectual flexibility and creativity (for an overview of this literature, see Nguyen and Benet-Martínez (2013)). These early studies of the relationship between acculturation and health relied on conceptualizations and measures of acculturation which assume that to the degree orientations to and competencies in the host culture increase, those of the culture of origin decrease. It is now widely accepted that this unidimensional approach to understanding acculturation processes is simplistic and may have

been at the core of the divergent early findings in this field (Schwartz et al., 2010).

More recently, it has been argued that some of the conflicting findings in this literature can be explained by considering the large differences in how bicultural individuals negotiate the tensions that multiple identities create in everyday life, a construct termed *bicultural identity integration* (BII; Benet-Martínez et al., 2002). The construct of BII has been studied in a wide range of acculturating samples, including not only immigrants and their descendants, as defined in the current study, but also in other acculturating samples including refugees, international adoptees, sojourners (*e.g.*, international students and professional expatriates), and those living in multicultural societies (Nguyen and Benet-Martínez, 2007). Individuals high in BII view their multiple cultures as compatible and complementary, and easily integrate these cultures in their daily lives, whereas individuals low in BII perceive their multiple cultures as distinct, oppositional and contradictory. Bicultural identity integration encompasses two distinct and independent dimensions. *Cultural harmony vs. conflict* reflects the degree of tension versus compatibility individuals perceive between their cultures, and it is assumed to capture affective aspects of the bicultural experience. For example, the experience of discrimination or intergroup relations stress may result in feelings of anger and distress. The second dimension, *cultural blendedness vs compartmentalization/ distance*, reflects the degree of overlap versus dissociation between the two cultures, and has been associated with learning and performance-related aspects of the immigration experience such as language proficiency or the amount of exposure to and identification with each culture (Benet-Martínez and Haritatos, 2005).

To the best of our knowledge, BII has not been considered in studies testing the role of the hypothalamic pituitary adrenal (HPA) axis - one of the body's main stress-responsive systems - in the link between stress and disease. Briefly, the activation of the HPA axis leads to corticotrophin-releasing hormone release from the hypothalamus, adrenocorticotropic hormone release from the pituitary gland and cortisol release from the adrenal cortex. Free cortisol then binds to receptors on the pituitary, hypothalamus and higher order brain structures, facilitating a negative feedback system by which the HPA axis regulates its own activity (Tsigos and Chrousos, 2002).

Existing studies on the effects of migration on HPA axis function are rooted in the earlier acculturation theories highlighting the negative aspects of assimilation processes. These studies mostly suggest that greater assimilation to the host culture is associated with unfavorable cortisol profiles, such as a flatter diurnal cortisol slope among more assimilated pregnant U.S. women of Mexican descent (D'Anna-Hernandez et al., 2012) and a blunted cortisol awakening response among more assimilated adult Mexican immigrants to the U.S. who are also high in neuroticism (Mangold et al., 2012) and childhood trauma (Mangold et al., 2010). The number of years since immigration to the United States, a measure sometimes used as a proxy for assimilation, was also associated with blunted diurnal cortisol among male but not female Latino immigrant farmworkers (Squires et al., 2012).

There are, however, also some hints pointing toward the importance of considering the stressfulness of the immigration experience, rather than just the experience itself. For example, one study reporting the absence of a link between assimilation and cortisol among adult Latina women, instead found a link between acculturative stress and a flatter diurnal cortisol slope as well as a blunted cortisol awakening response (Torres et al., 2018). Similarly, Garcia et al. (2017) report that the association between greater acculturative stress and poorer self-reported physical health is mediated by a blunted cortisol awakening response, an effect that remained significant after controlling for acculturation. It appears from these studies, similar to what has been concluded in the broader acculturation literature, that explaining cortisol dysregulation with a unidimensional model focused solely on processes related to assimilation to the host culture is simplistic, and a more multifaceted approach is warranted.

We propose that it would be important to consider BII in biopsychosocial studies of stress and health in immigrant and other acculturating samples. We further suggest that it may be particularly important to consider measures of stress reactivity because individual differences in stress reactivity have been hypothesized to partially explain why some individuals exposed to stress will proceed to develop disease whereas other individuals will not (Boyce et al., 1995; Cohen and Manuck, 1995; Lovallo and Gerin, 2003). The main goal of the present study was to test whether a link between BII and cortisol reactivity exists and, if so, in which direction. Because both BII and cortisol have been linked with perceived stress, this measure was included in the present study as well. Based on previous findings that cultural harmony is associated with affective aspects of the acculturation experience and blendedness with learning- and performance-related aspects thereof (Benet-Martínez and Haritatos, 2005), we hypothesized that cultural harmony but not cultural blendedness would be associated with perceived stress and cortisol reactivity.

## 2. Method

### 2.1. Participants

This study is part of a larger study of 158 university and community college students (Busse et al., 2017a, b; Campos et al., 2014). For the present report, 11 individuals were excluded because of missing or insufficient cortisol data and 22 individuals were excluded because neither they nor one of their parents were foreign-born. For two individuals both exclusion criteria applied, and thus, 127 individuals (57 male, 70 female) with a mean age of 20.4 years (SD = 2.1; range: 18–29 yrs) were included in the data analyses presented here. Most participants reported being Latino (68.3%), followed by East Asian (16.5%), other (13.4%), White (3.9%), and Mixed (2.4%). The 22 individuals who were excluded because neither they nor one of their parents were foreign-born, differed from the included sample in terms of ethnicity (White: 81.8%, Latino: 9.1%, other: 4.5%, Mixed: 4.5%). In line with previous publications from this dataset, ethnicity was dummy coded into Latino and non-Latino participants to maintain adequate sample size. About one third of the sample (37.8%) reported being foreign-born and immigrating to the United States during their own lifetime, with an average length of stay in the United States of 13.3 years (SD = 5.0, range 4–23 yrs). The remaining 62.2% were the U.S.-born children of immigrant parents. The majority of participants reported their socioeconomic background as lower middle class (45.7%; skilled trade, steady employment), and the remaining participants as upper working class (18.9%; skilled workers, steady employment), lower working class (18.1%; unskilled workers, steady employment) and upper middle class (17.3%; professionals, high earned income). Participants reported the average length of education for their fathers at 12.6 years (SD = 5.3) and for their mothers at 11.6 years (SD = 5.3).

Participants were recruited at the University of California, Irvine and surrounding community colleges. Exclusion criteria were medications known to affect cortisol, major medical conditions, speech or math phobia, drug or alcohol use, and tobacco use exceeding five cigarettes per day. Of note, none of the participants reported smoking regularly over the past six months. All study procedures were approved by the Institutional Review Board of the University of California, Irvine.

### 2.2. Overall procedure

Study days for all participants were scheduled to begin at 2 pm to control for the pronounced circadian variation in cortisol. After providing informed consent, and a 15-min rest period, a first saliva sample (−2 min) was collected. Participants were then escorted to an adjacent room to complete the Trier Social Stress Test (TSST; Kirschbaum et al., 1993). Following a 2 min instruction and 3-min preparation period, the actual laboratory stressor consisted of a 5 min mock job interview

followed by a 5 min arithmetic task in front of two neutral evaluators of diverse ethnicities (*e.g.*, Latino, European, East Asian, mixed background) and both sexes. Upon completion of the TSST, a second saliva sample was collected (+1 min), and participants were then escorted back to the waiting room, where they completed questionnaires and collected six additional saliva samples at +10, 20, 30, 45, 60 and 90 min relative to the end of the TSST. After collection of the last saliva sample, participants were thanked, carefully debriefed and awarded their choice of course extra credit (University of California, Irvine students only) or $50.

### 2.3. Measures

#### 2.3.1. Saliva sampling and cortisol assay

Saliva was collected using Salivettes (Sarstedt, Nümbrecht, Germany), stored at room temperature until the end of the study day and then frozen at −70 °C until assayed. After thawing, samples were centrifuged for 10 min at 2000*g* and 4 °C. Salivary free cortisol was determined in duplicated by an enzyme immunoassay (IBL America, Minneapolis, Minnesota). The sensitivity of the assay is 0.033 nmol/L, and the dynamic range is 0–82.77 nmol/L. Inter- and intraassay coefficients of variance are reported at 4.9% and 4.1%, respectively.

#### 2.3.2. Questionnaire measures

Self-report questionnaires were administered to assess U.S. acculturation, bicultural identity integration, and perceived stress. Moreover, because neuroticism was associated with cortisol reactivity in our previously published work drawing on this larger dataset (Campos et al., 2014) and because associations between BII and neuroticism have been demonstrated previously (Benet-Martínez and Haritatos, 2005; Chen et al., 2008), we controlled for this variable in relevant analyses.

##### 2.3.2.1. Acculturation.
U.S. acculturation was measured with the 13-item Anglo Orientation subscale (AOS) of the Acculturation Rating Scale for Mexican Americans-II (ARSMA-II, Cullar, Arnold, & Maldonado; 1995). Using a Likert-type response scale, with answer options ranging from *1 = not at all* to *5 = extremely often or almost always*, the ARSMA-II measures language use and preference; ethnic identity and classification; cultural heritage and ethnic behaviors; and ethnic interaction. While developed as a scale for use with Mexican Americans, the Anglo Orientation subscale is suitable for use with other ethnicities. Sample items are *I speak English*, and *I have difficulties accepting some ideas held by European Americans*. Scores were averaged across items, and higher scores indicate higher U.S. acculturation. Of note, we will not report on the Mexican American Subscale (MOS) of the ARSMA-II questionnaire because our sample is multicultural and not all individuals in the study could provide meaningful responses.

##### 2.3.2.2. Bicultural identity integration.
The Bicultural Identity Integration-2 scale measures bicultural individuals' perceived compatibility between their culture of origin and their host culture (Huynh, 2009; Huynh and Benet-Martínez, 2011). The 19 items of the Bicultural Identity Integration-2 scale are endorsed on a 5-point, Likert-type scale, with answer options ranging from *1 = strongly disagree* to *5 = strongly agree*. The questionnaire yields an overall score and two subscales assessing *blendedness vs. compartmentalization/distance* (9 items, α = .76) and *harmony vs. conflict* (10 items, α = .80). Higher scores indicate higher bicultural identity integration and, with reference to the subscales, higher levels of harmony and blendedness. Item examples are *I feel that my _____ and American cultures are incompatible* (harmony, reverse coded) and *I feel _____ and American at the same time* (blendedness). Because the two subscales reflect two independent constructs (Benet-Martínez and Haritatos, 2005), findings for the two subscales harmony and blendedness, but not for the overall scale, are reported.

##### 2.3.2.3. Perceived stress.
The Perceived Stress Scale (PSS) was used to measure the degree to which participants perceived that demands are exceeding their resources (Cohen et al., 1983). The 14-item version used here referred to stress perceptions over the past month (*e.g.*, "How often have you found that you could not cope with all the things you had to do?"). Participants rated each item on a 5-point scale ranging from *1 = never* to *5 = very often*. Responses to individual questions were averaged to create scale scores, with higher scores indicating more perceived stress.

##### 2.3.2.4. Neuroticism.
The 10-item Personality Inventory (TIPI) was used to measure neuroticism (Gosling et al., 2003). The TIPI has acceptable levels of convergence with longer personality measures and the two items measuring neuroticism tap the tendency for emotional instability and negative emotionality (*e.g.*, "I see myself as anxious and easily upset"). Participants rated items using a Likert-type scale, ranging from *1 = disagree strongly* to *7 = agree strongly*. Responses were averaged to create an overall score with high scores indicating more neuroticism.

### 2.4. Statistical approach

Two summary measures were calculated to capture the salivary cortisol response to the TSST. Overall cortisol secretion, covering the full assessment period (pre to + 90 min samples), was computed using simple area under the curve computations using zero as a reference line (termed, *cortisol AUCg*). To capture cortisol reactivity, we computed the *mean cortisol increase* by subtracting the pre-TSST cortisol value from the average of the first five cortisol values obtained following the TSST (+1 min–+30 min).

Correlations between variables are Pearson Product-Moment correlations. To test for differences between subgroups of participants, independent sample t-tests and $\chi^2$-tests were computed. Study hypotheses were tested with three separate linear regression models, with perceived stress, the mean cortisol increase and the cortisol AUCg as the outcome variables. In each model, neuroticism was entered into the model in Step 1. Cultural harmony, cultural blendedness, ethnicity (Latino *vs.* non-Latino) and nativity (U.S.-born *vs.* foreign-born) were then entered as predictor variables in Step 2. This set of variables was entered stepwise to assure that any emerging associations between these cultural variables of interest and our outcome variables were predictive above and beyond the known effects of neuroticism. In Step 3, up to four interactive terms (harmony X ethnicity, harmony X nativity, blendedness X ethnicity, blendedness X nativity), were included (method stepwise) to test if the associations between harmony or blendedness with the three outcome measures differed by ethnicity or nativity. For example, because the correlation between blendedness and the cortisol area under the curve was significant among Latinos but not among non-Latinos, the blendedness by ethnicity interaction was included in the relevant regression model in Step 2. Decisions about inclusion of specific interactive terms were based on correlations reported in Table 2, and for the purpose of this decision-making process only, trend-level associations (p < .10) were treated as if they were significant.

### 3. Results

#### 3.1. Preliminary analyses

Data were first examined for ethnicity (Latino *vs.* non-Latino), nativity (U.S.-born *vs.* foreign-born), and sex differences in sociodemographic variables (age, sex, SES, ethnicity, parental education), major study variables (harmony, blendedness, PSS, cortisol summary scores; see Table 1). Consistent with U.S. demographics, Latino participants in our sample came from lower SES families, reporting fewer years of education for their mothers, $t(119) = 5.39$, $p < .001$, and

**Table 1**
Participant Demographics and Major Study Variables by Nativity and Ethnicity.

| | Nativity | | | Ethnicity | | |
|---|---|---|---|---|---|---|
| | U.S.-born (n = 79) M(SD) or % | Foreign-born (n = 48) M(SD) or % | Group Comparison | Latino (n = 81) M(SD) or % | Non-Latino (n = 46) M(SD) or % | Group Comparison |
| Sex (% female) | 51.9% | 60.4% | $\chi 2(1) = .57$ | 48.1% | 67.4% | $\chi 2(1) = 3.65$^ |
| Age | 20.2 (2.1) | 20.7 (1.9) | $t(125) = -1.22$ | 20.5 (2.3) | 20.3 (1.5) | $t(125) = -.58$ |
| Ethnicity (% Latino) | 62.0% | 66.7% | $\chi 2(1) = .11$ | – | – | – |
| Nativity (% U.S.-born) | – | – | – | 60.5% | 65.2% | $\chi 2(1) = .74$ |
| Yrs of Education | | | | | | |
| Mother | 11.5 (5.3) | 11.5 (5.2) | $t(119) = -.43$ | 9.8 (4.9) | 14.6 (4.4) | $t(119) = 5.39$*** |
| Father | 12.2 (5.5) | 13.1 (4.9) | $t(117) = -.88$ | 11.0 (4.9) | 15.2 (4.9) | $t(117) = 4.56$*** |
| Family of Origin SES | | | | | | |
| % upper middle class | 13.9% | 22.9% | $\chi 2(3) = 2.04$ | 11.1% | 28.3% | $\chi 2(3) = 9.10$* |
| % lower middle class | 49.4% | 39.6% | | 44.4% | 47.8% | |
| % upper working class | 19.0% | 18.8% | | 21.0% | 15.2% | |
| % lower working class | 17.7% | 18.8% | | 23.5% | 8.7% | |
| US Acculturation | 3.91 (.41) | 3.73 (.41) | $t(125) = 2.42$* | 3.79 (.39) | 3.94 (.44) | $t(125) = 2.05$* |
| Bicultural Identity Integration | | | | | | |
| Overall Scale | 5.16 (1.01) | 4.93 (.88) | $t(125) = 1.30$ | 5.14 (.94) | 4.95 (1.0) | $t(125) = -1.12$ |
| Subscale: Harmony | 4.94 (1.27) | 4.88 (1.9) | $t(125) = .31$ | 5.00 (1.1) | 4.77 (1.3) | $t(125 = -1.02$ |
| Subscale: Blendedness | 5.40 (1.04) | 4.99 (.99) | $t(125) = 2.17$* | 5.30 (1.0) | 5.14 (1.1) | $t(125) = -.88$ |
| Perceived Stress | 37.6 (6.94) | 36.9 (7.80) | $t(125) = .59$ | 37.0 (7.5) | 37.9 (6.9) | $t(125) = .67$ |
| Cortisol | | | | | | |
| AUCg (random units) | 937.5 (496.7) | 1161.2 (931.6) | $t(107) = -1.62$ | 1094.6 (771.1) | 903.1 (556.9) | $t(107) = -1.35$ |
| Mean Increase (nmol/L) | 5.89 (8.48) | 8.79 (12.3) | $t(110) = -1.48$ | 10.0) | 7.00 (10.8) | $t(110) = -.04$ |
| Neuroticism | 2.98 (1.15) | 2.84 (1.5) | $t(125) = .58$ | 2.80 (1.2) | 3.16 (1.4) | $t(125) = 1.55$ |

Note: ^$p = .06$, *$p < .05$, ***$p < .001$.

**Table 2**
Pearson Product-Moment Correlations between Cultural (U.S. Acculturation, Cultural Harmony and Blendedness) and Health-Related Variables (Perceived Stress, Cortisol Summary Measures) in the Full Sample and Stratified by Nativity and Ethnicity.

| | Perceived Stress | | Cortisol | | | |
|---|---|---|---|---|---|---|
| | | | Mean Increase | | AUCg | |
| **Full Sample** | | | | | | |
| Harmony | −.36*** | | −.14 | | −.11 | |
| Blendedness | −.19* | | −.13 | | −.14 | |
| U.S. Acculturation | −.07 | | −.04 | | −.02 | |
| **By Nativity** | U.S.-born | Foreign-born | U.S.-born | Foreign-born | U.S.-born | Foreign-born |
| Harmony | −.41*** | −.28^ | −.24* | −.02 | −.14 | −.09 |
| Blendedness | −.28* | −.09 | −.18 | −.03 | −.16 | −.09 |
| U.S. Acculturation | −.08 | −.08 | −.04 | .04 | −.12 | .16 |
| **By Ethnicity** | Latino | Non-Latino | Latino | Non-Latino | Latino | Non-Latino |
| Harmony | −.26* | −.52*** | −.32** | .09 | −.19 | −.01 |
| Blendedness | −.14 | −.27^ | −.27* | .09 | −.24* | .08 |
| U.S. Acculturation | −.08 | −.07 | −.05 | −.01 | .04 | −.02 |

fathers, $t(117) = 4.56$, $p < .001$, as well as a lower social class background, $\chi^2 = 9.10$, $p < .05$, compared to non-Latino participants.[1] The Latino group was also less acculturated to the U.S., $t(125) = 2.05$, $p < .05$, and reported more experiences of discrimination, $t(118) = 5.44$, $p < .05$, compared to the non-Latinos. There was a non-significant trend for male non-Latinos to be under-represented compared to male Latinos and females in this sample, $\chi^2 = 3.65$, $p = .06$. U.S.-born individuals had significantly higher levels of U.S. acculturation, $t(125) = 2.42$, $p < .05$, and blendedness, $t(125) = 2.17$, $p < .05$ compared to foreign-born individuals, but the two groups did not differ in any other sociodemographic and major study variables. No sex differences were observed for any major study variables. Thus, nativity and ethnicity were included in the regression analyses reported

below whereas sex differences were not further considered.

As expected, significant intercorrelations were observed between cultural harmony and blendedness, $r = .50$, $p < .001$, and between the cortisol mean increase and cortisol area under the curve, $r = .63$, $p < .001$. To gain a first impression of associations between the cultural (harmony, blendedness, acculturation) and stress-related variables (perceived stress, cortisol reactivity), simple correlations were computed (see Table 2). Harmony was associated with less perceived stress in the full sample, $r = -0.36$, $p < .001$, as well as stratified by nativity (U.S.-born: $r = -0.41$, $p < 0.001$; foreign-born: $r = -0.28$, $p = .06$) and ethnicity (Latino: $r = -0.26$, $p = .02$; non-Latino: $r = -0.52$, $p < .001$). Blendedness was associated with less perceived stress in the full sample, $r = -0.19$, $p < .05$, and among U.S.-born individuals $r = -0.28$, $p < .05$, with a non-significant trend among non-Latinos, $r = -0.28$, $p = .08$. Neither harmony nor blendedness were associated with the two cortisol summary scores in the full sample. However, harmony was associated with a smaller cortisol mean increase among

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[1] Including SES in the regression analyses reported below did not change the significance of any findings, and a decision was made to report findings of the more parsimonious models not including SES.

**Table 3**
Linear regression models in the full sample with perceived stress, the mean cortisol increase and the AUC as the outcome variables.

| | Perceived Stress | | | | Mean Cortisol Increase | | | | AUCg | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | SE | ß | t | B | SE | ß | t | B | SE | ß | t |
| **Step 1** | | | | | | | | | | | | |
| Neuroticism | 2.32 | .46 | .41 | 5.07*** | −1.54 | .71 | −.20 | −2.17* | −131.2 | 49.5 | −.25 | −2.65** |
| **Step 2** | | | | | | | | | | | | |
| Neuroticism | 1.86 | .47 | .33 | 3.94*** | −2.06 | .73 | −.27 | −2.80** | −162.3 | 50.9 | −.31 | −3.19** |
| BII-Harmony | −1.51 | .51 | −.25 | −2.97** | −2.02 | .88 | −.22 | −2.30* | −130.0 | 61.6 | −.20 | −2.11* |

Note: Variables were entered stepwise.
*p < .05, **p < .01, ***p < .001

U.S.-borns and among Latinos, and blendedness was associated with a reduced cortisol mean increase and a smaller cortisol AUC among Latinos, $r$'s ranging from $r = -0.24, p < .01$ to $r = -0.32, p < .01$. No associations between U.S. acculturation and any of the stress-related measures were observed in the full sample or when stratified by nativity or ethnicity. Thus, U.S. acculturation was not included in multivariate models[2].

In terms of neuroticism, we found a negative association between neuroticism and BII harmony ($r = -0.33, p < .001$) and BII blendedness ($r = -0.19, p = .03$). Neuroticism was further positively associated with perceived stress ($r = .41, p < .001$) and negatively associated with the two cortisol summary measures (AUCg: $r = -0.25, p = .01$; cortisol mean increase: $r = -.20, p = .03$), suggesting that neuroticism is an important variable to control for in regression analyses.

### 3.2. Hypotheses testing

When neuroticism was entered in Step 1 of a regression model with perceived stress as the outcome variable, the overall model emerged as significant, $F(1126) = 25.65, p < .001$, explaining 16.4% of the variance in the model (Table 3). Inclusion of harmony, blendedness, nativity and ethnicity in Step 2 (stepwise) also yielded a significant model, $F(2126) = 18.04, p < .001$, increasing the explained variance to 21.3% and representing a significant improvement over model 1, $F_{change}(1124) = 8.83, p = .004$. In this second model, both neuroticism and harmony emerged as significant, suggesting that harmony is associated with perceived stress above and beyond any effects neuroticism has on perceived stress.

For cortisol, two separate models were run, one for the mean cortisol increase and one for the AUCg (Table 3). In terms of the mean cortisol increase, a model with neuroticism as the sole predictor variable emerged as significant, Step 1, $F(1111) = 4.69, p = .03$, explaining 3.2% of the variance in the model (Table 3). When harmony, blendedness, nativity and ethnicity were included in Step 2 (stepwise), the model remained significant, $F(2111) = 5.11, p = .01$. Both neuroticism and harmony were negatively associated with the mean cortisol increase in this model. Model 2 reflected a significant improvement over model 1, $F_{change}(1109) = 5.33, p = .02$, and the variance explained in model 2 was 6.9%, suggesting that harmony is a significant predictor variable above and beyond any effects of neuroticism.

Similar findings were observed for the cortisol AUCg. Again, the model was significant in Step 1 which included only the control variable neuroticism, $F(1108) = 7.02, p = .01$, explaining 5.3% of the variance in the model (Table 3). Inclusion of harmony, blendedness, nativity and ethnicity in Step 2 (stepwise) once again led to a significant
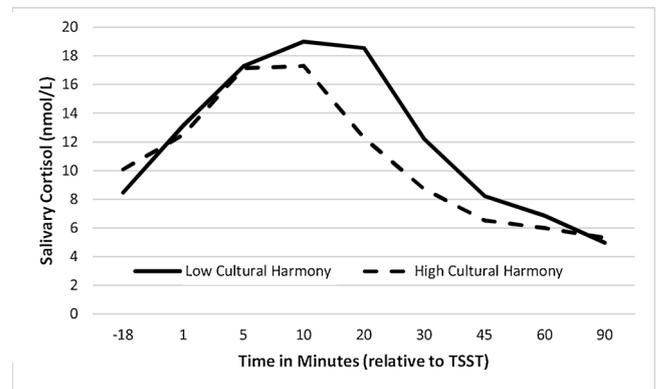


**Fig. 1.** Cortisol Responses to the Trier Social Stress Test stratified by cultural harmony.
*Note:* For illustrative purposes. Lines represent cortisol values (nmol/L) at one standard deviation above and below the mean for cultural harmony.

model, $F(2108) = 5.85, p = .004$, reflecting a significant improvement over the model in Step 1, $F(1106) = 4.45, p = .04$ and explaining 8.2% of the variance in the model. Both neuroticism and harmony were negatively associated with the cortisol AUCg in Step 2, again suggesting that harmony predicts above and beyond the effects of neuroticism. Relevant interactive terms were included in all three regression models (perceived stress, cortisol mean increase, AUCg) in Step 3, but this did not yield a significantly improved model in any case. For illustrative purposes, salivary cortisol trajectories in individuals high and low in cultural harmony are displayed in Fig. 1.

### 4. Discussion

The findings of our study suggest that being able to smoothly integrate cultures affects perceived stress and salivary cortisol trajectories following an acute laboratory stressor, a finding with considerable implications for immigrant health. In our sample of U.S. immigrants and U.S.-born children of immigrants, we found that perceiving one's bicultural identity as harmonious (i.e., marked by two cultures that coexist in an integrated fashion) was associated with lower perceived stress, and lower salivary cortisol following a laboratory stressor as indicated by reduced cortisol reactivity and reduced overall cortisol secretion. Conversely, perceiving the two cultures as low in harmony (*i.e.*, marked by conflict or tension) was associated with higher perceived stress, higher cortisol reactivity and higher overall cortisol secretion. Notably, these patterns were only observed for cultural harmony and not for cultural blendedness or U.S. acculturation; moreover, all findings controlled for the known effects of neuroticism on cultural harmony (Benet-Martínez and Haritatos, 2005; Chen et al., 2008). Our findings make two important contributions. First, they extend a literature that has primarily focused on the importance of BII on mental health and physical health outcomes to include a physiological pathway

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[2] All analyses reported below were also conducted with U.S. acculturation included as a predictor variable. Inclusion of this variable did not change the significance of the results, and in none of the models did U.S. acculturation emerge as a significant predictor.

that is a well-established means through which psychosocial experiences affect health. And second, they show that BII specifically characterized by harmony (and not by cultural blendedness or U.S. acculturation) is associated with perceived stress and salivary cortisol following a laboratory stressor above and beyond the known effects of neuroticism, and thus likely has consequences for immigrant health. This finding is important because it adds precision to a research literature on acculturation that has been criticized as being overly broad and lacking a nuanced consideration of the many ways that acculturation experiences can unfold in individual lives (Schwartz et al., 2010; Viruell-Fuentes, 2007).

The BII construct captures the extent to which a person feels that their cultures exist in balance or clash (harmony) and whether one's cultures have overlapping qualities or are too different to bring together (blendedness). Interestingly, only cultural harmony was relevant to the health factors we studied. BII Cultural Harmony and BII Cultural Blendedness are relatively independent constructs (Benet-Martínez, 2012). While both harmony and blendedness were directly associated with perceived stress and salivary cortisol in at least some of the simple correlations, regression analyses allowing us to compare the relative influence of each factor consistently showed that harmony was the more relevant of the two. This pattern suggests that being able to feel that one's cultures can co-exist in harmony may be more important for immigrant health than perceiving one's two cultures as similar.

In some ways, these findings are not surprising. A robust body of research has convincingly linked negative emotions as well as experiences eliciting these emotions, such as discrimination or rejection, to worse health outcomes (e.g., Sanders-Phillips et al., 2009; Tomfohr et al., 2016). The present findings are in line with this pattern. Previous literature has shown that cultural harmony captures the affective aspects of bicultural experience (e.g., feelings of belonging and positive emotion; anger and distress resulting from discrimination) whereas cultural blendedness has been more convincingly linked with the learning and performance-related aspects (e.g., language acquisition, amount of exposure to each culture) of the immigration experience (Benet-Martínez and Haritatos, 2005). Thus, it makes sense that the affective quality of the bicultural experience would be more prominently linked with health outcomes.

In other ways, however, the findings are surprising. BII reflects an individual's subjective experience with their two cultures, but this subjective experience is partly shaped by the context of reception that an individual encounters (Schwartz et al., 2010). Our sample was majority Latino and comprised of immigrants and the U.S. born children of immigrants. Latinos in the U.S. are likely to be marginalized and discriminated against (Viruell-Fuentes, 2007). This negative context of receptivity is well-documented and has been associated with poorer health with more time in the U.S. (Abraído-Lanza et al., 1999). Consistent with U.S. demographics, our Latino sample was also lower in markers of socioeconomic status relative to their non-Latino counterparts. It is, thus, particularly interesting that cultural harmony still predicted markers indicative of more favorable health. While this pattern of resiliency is well established in the research literature on Latino health (Ruiz et al., 2013), it is nevertheless noteworthy. For Latinos, it is possible that cultural harmony offers a pathway to protecting health from worsening with more time in the U.S. This possibility has not been studied, but merits future examination. There are also implications here for the BII construct more generally. For example, to more fully understand how the extent to which a welcoming context can facilitate the development of a harmonious bicultural identity, future research should examine more positive receiving contexts (e.g., European immigrants to the U.S.). In turn, findings from that work could point to changes to receiving contexts that could be protective of immigrant health.

Our study also suggests that cultural harmony is associated with perceived stress and cortisol reactivity in this immigrant sample, whereas U.S. acculturation per se is not. This finding adds to a growing body of work suggesting that measures of acculturation to the host culture are too broad and insufficient to reliably predict health outcomes and that the harmony vs. conflict dimension of bicultural identity integration may more appropriately capture health-related processes relevant to the immigrant experience (e.g., Benet-Martínez et al., 2002). This finding implies that migrant health is not simply a function of how successful immigrants are at immersing themselves into the new culture by learning the language, increasing exposure to both cultures and finding ways to integrate both. It instead suggests that migrants' direct experiences of the host culture as welcoming and inclusive versus devaluing and hostile is at least as important and should be the target of intervention on both an individual and public health level.

In terms of cortisol specifically, our study to the best of our knowledge is the first to demonstrate an association between cortisol reactivity and cultural harmony. Establishing this link is important because stress reactivity, including cortisol reactivity, has been suggested to be an important physiological pathway through which stress can influence health (Boyce et al., 1995; Cohen and Manuck, 1995; Lovallo and Gerin, 2003). Specifically, in our regression analyses we found that low cultural harmony was a significantly associated with increased cortisol reactivity, after controlling for the effects of neuroticism. Previous studies of cortisol in this context were limited in that they draw on a unidimensional construct of U.S. acculturation. These studies for the most part suggest that blunted cortisol is associated with more U.S. assimilation, although most of the positive findings were limited to subgroups of individuals (D'Anna-Hernandez et al., 2012; Mangold et al., 2012, 2010; Squires et al., 2012). In our own analyses, we found no evidence of an association between cortisol reactivity and U.S. acculturation or nativity.

Looking forward, it is important to better understand the sociodemographic and psychosocial characteristics of individuals who are able to achieve high cultural harmony; and the attitudes held and circumstances present in host cultures that facilitate or hinder the development of cultural harmony. Studies rigorously addressing these questions will provide the empirical knowledge needed to develop targeted interventions for immigrants as well as individual members and groups within the host culture. Prospective studies, following recent immigrants over a period of time would make a particularly important contribution. A limitation of our study was that our sample was not large enough to meaningfully test our hypotheses among members of other ethnicities, and future studies will need to test whether the present findings are applicable to members of other ethnicities. Moreover, our findings are specific to immigrants to Southern California and should be replicated in other immigrant samples both within and outside of the United States as well as other acculturating samples. Finally, it is important to note that our sample consisted of university and college students whose migration experiences differ from those of other immigrants in that students have more access to social and educational resources and different current stress experiences compared to other migrants of migrants of similar racial/ethnic background (e.g., labor migrants).

In sum, the present study of first- and second-generation immigrants suggests that cultural harmony, a subcomponent of the broader BII concept, is associated with perceived stress. It is also, to the best of our knowledge, the first study to demonstrate an association between cultural harmony and salivary cortisol responses to the TSST. Our findings imply that immigrant health depends, at least in part, on whether immigrants are able to integrate and feel good about both their cultural identities, and that the development of a state of cultural harmony depends on the immigrant as well as the members of the host culture. Simply put, the extent to which immigrants are able to think of themselves as having cultural identities that are positively regarded and smoothly integrated — and the extent to which the sending and receiving societies can facilitate these feelings — bodes well for immigrant health.

## Conflicts of interest

None

## Disclosure

## Acknowledgements

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