



Published in final edited form as:

Cultur Divers Ethnic Minor Psychol. 2018 October ; 24(4): 510–520. doi:10.1037/cdp0000218.

Acute Salivary Cortisol Response among Mexican American Adolescents in Immigrant Families

Su Yeong Kim¹, Minyu Zhang¹, Katharine H. Zeiders², Lester Sim³, and Marci E. J. Gleason¹

¹Department of Human Development and Family Sciences, University of Texas at Austin

²Norton School of Family and Consumer Sciences, University of Arizona

³Department of Psychology, University of Michigan

Abstract

Objectives—Though previous research indicates that language brokering can be stressful, the findings are mixed, pointing to potential moderators of the association. Guided by an ecological perspective, we examined the role of individual, family, and environmental factors in Mexican American adolescents' acute cortisol responses to language brokering.

Methods—The study consisted of 46 Mexican American adolescents recruited around a metropolitan city in central Texas. Participants translated a difficult medical document from English to Spanish for their parents, followed by an arithmetic task (modeled after the Trier Social Stress Test). Participants' perceptions (perceived efficacy and parental dependence), parental hostility, and discrimination experiences were assessed via self-report and were examined as moderators of adolescents' responses to the task.

Results—Results revealed differential responses to the task based on individual, family, and environmental factors. High efficacy and low dependence/parental hostility/discrimination related to stress responses characterized by low baselines, steeper reactivity, and faster recovery. Low efficacy and high dependence related to greater baseline stress and a slower recovery. High levels of parental hostility related to a slower recovery. High levels of discrimination related to greater baseline stress.

Conclusions—The study demonstrates that the modified TSST task can elicit an acute HPA axis response, but the nature of this response is dependent upon participants' perceptions of language brokering (parental dependence and efficacy), parental hostility, and discrimination experiences. Adolescents' individual characteristics and contextual demands remain important considerations in understanding their acute stress responses.

Keywords

acute stress; cortisol; Mexican American; language brokering; parental hostility; discrimination

When minority children in immigrant families surpass their parents' English skills, they may begin translating and interpreting between the family's heritage language and English for their parents (Kim, Hou, Shen, & Zhang, 2017). Approximately 80% of minority children in immigrant families regularly engage in such activity (Chao, 2006; McQuillan & Tse, 1995). Because translation often occurs in complex situations (Tse, 1995), this activity, "language brokering," is theorized to increase adolescents' feelings of pressure and stress. However, the literature reveals a somewhat mixed picture: some evidence suggests that translating experiences can be stressful in certain contexts (e.g., when language brokering is perceived as an acculturation stressor; Kam, 2011; Love & Buriel, 2007), whereas other findings point to the benefits of translating, such as enhanced metalinguistic abilities and interpersonal skills (Malakoff & Hakuta, 1991; Valdés, 2003). Considering these inconsistencies in the literature, it is likely that the effects of language brokering are dependent on a number of contextual factors. Further, the psychological effects of language brokering are also likely to be reflected in adolescents' biological and physiological responses. Few studies, however, have explored how language brokering impacts adolescents' physiology. Given that physiological stress reactivity has been related to health outcomes (Lovallo, 2016), understanding the stress response activated by an acute stressor that includes a common cultural experience, such as language brokering, may elucidate the observed health disparities in ethnic minority groups (Prado & Pantin, 2011).

Past research suggests that examining factors unilaterally (attending to only psychological, or only socio-environmental factors) provides a perspective of ethnic minority health that may be too narrow (Stokols, 1996), given the possibility of oversimplifying how these single factors are related to health issues in minority populations (Anderson, 1998; Taylor, 2011). To understand the effects of language brokering on adolescents' physiology, we took an ecological approach (Bronfenbrenner & Morris, 2006) and examined how psychological determinants – including adolescents' perceptions of their language brokering experiences, hostile interactions between parent and child, and adolescents' discriminatory experiences – contributed to variability in youths' physiological responses to a laboratory protocol that involved language brokering as a component of the acute stressor. In particular, we focused on the hypothalamic-pituitary-adrenal (HPA) axis and investigated the relation between language brokering and the HPA axis stress hormone, *cortisol*. Given that translating medical documents is one of the most stressful language brokering activities performed by children in immigrant families (Katz, 2014), we asked adolescent participants in the current study to translate a difficult medical document. This task was modeled after the well-validated Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). Specifically, we assessed the physiological activating phenomenon of an acute stressor, using a modified version of the TSST in which the original speech task was changed to a language brokering task; this was followed by an arithmetic task, as in the original TSST. In addition, we examined the moderating effects of individual, familial, and environmental factors on the process of stress reactivity and recovery that occurs when adolescents in immigrant families are faced with our modified acute stressor.

Assessing Physiological Stress Responses

The HPA axis is one of the major stress response systems in the human body. When individuals encounter an acute stressor, a complex cascade of events occurs involving the hypothalamus, the pituitary gland, and the adrenal cortex, eventually resulting in the release of cortisol into the blood stream (Kudielka, Hellhammer, & Kirschbaum, 2007). The HPA axis is equipped with feedback mechanisms that effectively shut off the release of cortisol when the individual no longer perceives the stimulus to be stressful (Chrousos & Gold, 1992). Thus, an expected acute stress response to a stressor (i.e., a response normatively associated with better health outcomes) consists of a low baseline cortisol level, a steep increase in cortisol following the stressor, and a decline in cortisol during the recovery process (McEwen, 2002).

A common method used to assess the acute response of the HPA axis is the TSST (Kirschbaum et al., 1993). The TSST is a laboratory paradigm that evokes stress reactivity in individuals by having them complete an evaluative speech and arithmetic task, during which participants' salivary cortisol is taken at multiple time points. The TSST is well validated and is often adopted by researchers to ascertain variations in stress reactivity amongst different populations (Allen et al., 2017). We designed a difficult acute stress test involving a language brokering task in place of the usual speech task, followed by the same arithmetic task used in the unmodified TSST, and examined Mexican American adolescents' cortisol responses. We hypothesized that, to the extent to which our acute stressor was experienced as stressful, Mexican-origin adolescents' cortisol levels would be elevated. It is important to note that the literature examining acute cortisol responses has indicated variations in the stress response, such as high baseline stress, low reactivity and/or slow recovery, that signal potential dysregulation in the human physiological system (Dickerson & Kemeny, 2004). Such variations may be due to characteristics of the stressor, or they could be due to differences in individual resources or individual challenges. We explore these dimensions below.

Moderators of the Acute Stress Response

Individual perceptions

Language brokers are likely to appraise their experience in ways that may amplify or attenuate their cortisol responses. Past research on language brokering has revealed both positive and negative adolescent outcomes related to language brokers' subjective feelings. For example, positive perceptions, such as feeling useful due to language brokering, have been associated with greater self-esteem (Weisskirch, 2007), whereas negative perceptions, such as feeling burdened by translating, can indirectly relate to increased substance use (Kam & Lazarevic, 2014b). Though the link between language brokering and cortisol activity is unclear, past findings suggest that subjective perceptions play a key role in threat appraisals, and thus, in turn, cortisol responses (Spies, Margolin, Susman, & Gordis, 2011). Therefore, we sought to examine the moderating role of adolescents' *perceptions* of language brokering and HPA axis activity in the current study.

Specifically, we were interested in examining perceived language brokering efficacy and parental dependence as variables that may moderate cortisol responses (Kim, Hou, Shen, et al., 2017). Feeling efficacious about the translating activity can potentially improve adolescents' physiology, leading to more adaptive stress responses. Indeed, past research suggests that greater perceived self-efficacy buffers against assessments of potential threat. For example, O'Leary (1992) reviewed literature on self-efficacy and health and revealed that self-efficacy related to several components of the stress response system, including HPA axis activity. Using an AUC (area under the curve) approach, Nierop, Wirtz, Bratsikas, Zimmerman, and Ehlert (2008) also found that self-efficacy was accompanied by lowered cortisol responses to a TSST paradigm. Wiedenfeld et al. (1990) demonstrated that manipulating and increasing self-efficacy over phobic stressors in a laboratory setting led to an immune-enhancing effect, affecting both self-reported anticipatory stress and absolute levels of cortisol activation. Taken together, these findings suggest it is likely that high levels of perceived efficacy may correspond with experiencing ease when engaging in translation, potentially lowering baseline stress (prior to the event) and/or encouraging the body's ability to respond quickly and recover from the stress of language brokering.

On the other hand, parental dependence, or the degree to which adolescents perceive that their parents are not in control and that their parents rely on them for translation, is likely to lead to different physiological responses. Some research on the phenomenon of 'parentification', the process of role reversal that occurs as a result of adult parents relying on their children for support (Stein, Rotheram-Borus, & Lester, 2007), suggests that language brokering may lead to greater parental reliance on children. High levels of perceived parental dependence may reflect this over-reliance and relate to negative feelings of burden and obligation on the part of the children (Wu & Kim, 2009). Within the literature, there is further evidence to suggest that providing daily family assistance, such as translating for family members, can "get under the skin" and affect biological inflammatory markers such as soluble interleukin-6 receptor and C-reactive protein, resulting in worse health outcomes for Latino adolescents (Fuligni et al., 2009). Extending from this line of research, perceived parental dependence may culminate in internalized stress for the adolescent, potentially exacerbating stress reactivity.

However, it is important to point out that some scholars have wondered whether parental reliance may actually confer *benefits* to language brokers instead (Dorner, Orellana, & Jiménez, 2008; Orellana, Dorner, & Pulido, 2003). Kam (2011) anchored her arguments in role theory and suggested that language brokering may facilitate interpersonal scripts in Mexican heritage cultures; for this reason, it may not necessarily be implicated in detrimental outcomes for language brokering adolescents. The threat assessment associated with translating is likely to vary depending on how adolescents construe their parents' dependence on them as language brokers, and their physiological/cortisol outcomes are likely to vary correspondingly. Accordingly, we sought to determine whether positive and negative perceptions of their language brokering experience moderated adolescents' physiological responses to our modified TSST by examining adolescent brokers' baseline stress levels, reactivity, and recovery processes.

Contextual factors

Researchers examining contextual factors that affect HPA axis activity have uncovered mixed findings. Stressful situations should, in theory, result in heightened HPA axis responses; however, studies examining the impact of contextual factors, including chronic burnout or stress, on the TSST response show variations, including amplified, blunted or no acute responses (Kudielka, Hellhammer, & Wüst, 2009). This variation may point to alterations or deviations in the HPA axis response pathways that could indicate HPA axis dysregulation (Berger & Sarnyai, 2015; Chrousos & Gold, 1992). Related to this idea is research on allostatic load (McEwen, 1998), which posits that stress response systems, such as the HPA axis, may undergo wear and tear under chronic activation. Thus, the ways in which the acute response is moderated by contextual stressors is likely dependent on the nature and persistence of these stressors. If stressors are chronic, we may observe hyporesponsivity to the TSST, as prior research has found dampened stress responses among chronically burdened participants (Kudielka, Bellingrath, & Hellhammer, 2006). Specifically, chronic stressors are purported to enhance activation of the HPA axis, manifesting in continual secretion of cortisol into the bloodstream (Miller, Chen, & Zhou, 2007); for this reason, a possible precursor to hyporesponsivity may be elevated physiological stress levels prior to exposure to the acute stressor. In the absence of chronic stress, however, we might expect the typical pattern of amplified cortisol activity in response to an acute stressor, because cortisol mobilizes human physiological systems to manage immediate metabolic demands associated with acute stressors (Dickerson & Kemeny, 2004). To address how contextual factors may influence HPA axis activity during translation, we examined perceived parental hostility and adolescent language brokers' discrimination experiences to account for familial and environmental influences.

Parental hostility—Family dynamics can influence language brokering experiences (Martinez, McClure, & Eddy, 2009). In particular, the quality of parent-child relationships may tangibly influence adolescents' language brokering experiences. For example, Kim, Hou, and Gonzalez (2017) revealed that adolescent language brokers who reported a strong sense of alienation from parents also reported high levels of depressive symptoms. Though no studies have bridged the association between negative parent-child dynamics and biological activity during language brokering, some evidence suggests that adverse familial environments (e.g., conflict in family of origin) are associated with heightened acute stress reactivity (Luecken & Appelhans, 2006). Spies (2011) found that adolescents with internalizing symptoms in hostile familial environments exhibited blunted AUC cortisol responses to an acute family conflict discussion in the laboratory. Additionally, risky familial environments were also associated with children's basal and short-term reactivity to a strange situation task (Sturge-Apple, Davies, Cicchetti, & Manning, 2012). Elsewhere, parental support, which may be construed as the converse of parental hostility, has been found to have buffering effects on young children's cortisol response to a TSST paradigm (Hostinar, Johnson, & Gunnar, 2015; Marsman et al., 2012). As past research shows that children experience greater levels of negativity and less closeness with parents during adolescence (McGue, Elkins, Walden, & Iacono, 2005), parent-child hostility may serve as a catalyst that heightens maladaptive physiological activity during the process of language brokering. Specifically, we postulate that for adolescent language brokers who are situated in

inimical familial contexts, hostile parent-child relationships may play a part in their acute stress responses. In any case, it is likely that parental hostility is an important familial factor that can influence physiological activity. Especially for adolescent language brokers who are required to translate despite their perception that they must do so in a hostile environment, cortisol reactivity should be implicated during an acute stressor that includes the translation activity.

Discrimination—A frequent and prevalent social stressor that shows a robust relation to heightened acute stress responses and diminished physical health is discrimination (Berger & Samyay, 2015; Busse, Yim, & Campos, 2017; Wagner, Tennen, Finan, Ghuman, & Burg, 2013). Various studies have utilized the TSST to demonstrate that chronic exposure to discrimination is related to physiological cortisol activity (Busse et al., 2017; Lucas, Pierce, et al., 2017; Lucas, Wegner, et al., 2017). Lucas and colleagues (2017), for example, showed that higher levels of perceived discrimination related to more dysregulated biological stress responses in both reactivity and recovery for African Americans (i.e., low levels of stress mobilization to an acute stressor). Within the literature, there is further evidence to suggest that discrimination can exacerbate the effects of other stressors, including language brokering. For example, it has been suggested that when stereotypes and discrimination are apparent, Arab American language brokers may experience greater burden when engaging in translation (Nash, 2017). Additionally, Doane and Zeiders (2014) revealed that discrimination was a significant moderator that heightened the relation between negative affect and within-person cortisol activity. In particular, in high discrimination contexts, negative affect was found to relate to greater within-person cortisol activity; this relation did not hold in low discrimination contexts. Accordingly, exploring the ways that discrimination can potentially exacerbate the effects of the language brokering experience on acute HPA axis activity will give us a clearer picture of how multiple factors may work together to impact ethnic minority adolescents' HPA axis activity during language brokering.

The Current Study

We first examined the potential link between language brokering and physiological stress by adapting a laboratory protocol designed to measure physiological responses, after which we assessed the influence of moderators on HPA activity, including perceived language brokering experiences (self-efficacy and parental dependence), perceived parental hostility, and discrimination experiences. We hypothesized that, overall, Mexican-American adolescents would demonstrate an acute stress response. Specifically, we hypothesized that:

- H1** Language brokers would show low baseline stress levels, an increase in cortisol to the acute stressor, and recovery after the modified TSST task.

As for moderation, we hypothesized that when language brokers felt highly efficacious about translating, they would perceive the activity to be manageable, and exhibit an adaptive stress response. Considering the mixed findings concerning parental dependence and its effects on language brokering, our hypotheses for parental dependence were exploratory in nature. We suspected that adolescent language brokers might be more inclined to perceive dependence as a form of obligation, possibly resulting in heightened threat appraisals. Accordingly, we hypothesized that when language brokers perceived their parents to be

highly dependent on them to broker, they would experience corresponding feelings of burden, resulting in a less adaptive stress response. In sum, we hypothesized that:

- H2a** Language brokers with high levels of language brokering efficacy would have low baseline stress levels, steeper stress reactivity, and faster recovery patterns.
- H2b** Language brokers with high levels of parental dependence would have higher baseline stress levels, less steep stress reactivity, and slower recovery patterns.

For parental hostility, we hypothesized that adolescents who reported low levels of parental hostility would demonstrate an adaptive stress response. In line with both our discussion on HPA hypo-responsivity and past research suggesting that maternal emotional unavailability affects children's basal cortisol (Sturge-Apple et al., 2012), we expected elevated levels of baseline cortisol prior to exposure to the acute stressor. Further, considering the potentially stress-activating nature of language brokering, we expected that adolescents would show less adaptive stress responses when they reported a high degree of parental hostility.

- H2c** Language brokers who reported high levels of parental hostility would have high baseline cortisol levels, less steep stress reactivity and slower recovery.

For discrimination, we hypothesized that language brokers who reported lower levels of discrimination would exhibit an adaptive stress response: low baseline cortisol levels, steeper stress reactivity, and faster recovery patterns. For those reporting higher levels of discrimination, we expected patterns predicted by HPA hypo-reactivity theory (Kudielka et al., 2006; Kudielka et al., 2009), such that:

- H2d** Language brokers experiencing high levels of discrimination would demonstrate high baseline cortisol even prior to exposure to the acute stressor, a blunted HPA axis acute response, and slower recovery.

Method

Participants

Participants were 46 Mexican American adolescents (56.5% female) who identified as language brokers for their mothers. They were recruited through public records, school presentations, and community recruitment in and around a metropolitan city in central Texas. Research assistants distributed a letter describing the research project and a permission slip for adolescents' parents. If families signed and returned the slip, and met the inclusion criteria – being Mexican-origin and having a child who translates for the mother – during the initial screening call, a family visit was scheduled. Adolescents were, on average, 11.89 years old ($SD = 0.43$, range from 11 to 13 years old) and the majority (73.9%) were U.S.-born. The average number of years of living in the U.S. was 10.58 ($SD = 2.97$) for the Mexico-born participants. Adolescents frequently translated for their mothers; 65.2% reported translating *a few times a week* or *daily*. All mothers were born in Mexico, and 80% of them did not have a high school diploma. The majority (70.7%) of the participants reported an annual family income that was in the range of \$30,001 to \$40,000 or less.

Procedure

Adolescents completed a modified TSST (TSST; Kirschbaum et al., 1993) in their homes. Research personnel arrived at the family's home and gave the participants (mother and adolescent) instructions on the task, which involved the adolescent standing in front of a microphone and translating a medical treatment protocol from English to Spanish for the mother in the presence of one research assistant who acted as the adult in a medical setting, along with two other research assistants as judges. All three research assistants wore white lab coats and evaluated the adolescent by making notes on their clipboards with stern facial expressions; they stated, "Please continue," whenever the participant stalled during the translation task. Following this was an arithmetic task, in which adolescents started with a three-digit number and were instructed to subtract 7 from it sequentially, until they reached 0. If there was a mistake, the participant was asked to start over from the beginning. Research assistants also acted like they were videotaping the adolescent doing the translation and arithmetic tasks, although the camera was never actually turned on. Seven saliva samples were collected throughout the task (see Table 1 for detailed collection times): at baseline (after research assistants arrived), after instructions on the translation task, after the translation task but before the arithmetic task, after completion of both tasks, and at three recovery periods (30, 45, and 60 minutes after completion of the arithmetic task). All study protocols began after 4 p.m. (times ranged from 4:05 p.m. to 8:35 p.m.) because cortisol levels follow a circadian rhythm and are more stable beginning in the late afternoon (Kudielka et al., 2007). Participants completed measures of their overall positive and negative experiences of language brokering for their mothers. The study protocol was approved by the Institutional Review Board of the first author's university.

Measures

Salivary Cortisol—Salivary samples were collected using SaliCaps (IBL International GmbH, Hamburg, Germany), which were stored on an ice pack during the study session, and then stored at 20 C before being sent to Biochemisches Labor in Trier, Germany, to be assayed for cortisol. Cortisol concentration was determined using a time-resolved fluorescence immunoassay (see Dressendörfer, Kirschbaum, Rohde, Stahl, & Strasburger, 1992 for detailed description). Intra-assay coefficients of variation (CVs) were between 4.0% and 6.7%, and inter-assay CVs were between 7.1% and 9.0%. Cortisol values were log-transformed before analyses to normalize the distribution.

Adolescent Discrimination Experiences—Adolescents completed a nine-item measure (Kessler, Mickelson, & Williams, 1999) asking how frequently they experienced discrimination on a daily basis as a general measure of overall mistreatment (1 = *Never*, 2 = *Rarely*, 3 = *Sometimes*, 4 = *Frequently*). A sample item is "I am treated with less courtesy than other people." The discrimination measure has been validated for use with Latinos and is related to a range of outcomes such as depressive symptoms and substance use (e.g., Chithambo, Huey, & Cespedes-Knadle, 2014; Martinez, McClure, Eddy, & Wilson, 2011). Cronbach's alpha was .88.

Maternal Hostility—Adolescents completed a six-item scale adopted from the Iowa Youth and Family Project (Ge, Best, Conger, & Simons, 1996), concerning their perceptions of

maternal hostility (1 = *Never*, 2 = *Almost never*, 3 = *Not often*, 4 = *About half the time*, 5 = *Fairly often*, 6 = *Almost always*, 7 = *Always*). Sample items include “Your mother criticizes you or your ideas” and “Your mother insults or swears at you.” The maternal hostility measure has been validated for use with Latino samples and shows predictive validity with positive parent-child relationships that tie to language brokering (e.g., Kim, Hou, Shen, et al., 2017). The Cronbach’s alpha for the scale was .87.

Adolescents’ Perceptions of the Language Brokering Experience—Using a scale ranging from “1 = *strongly disagree*” to “5 = *strongly agree*,” adolescents assessed their overall sense of positive (*efficacy*) and negative (*parental dependence*) feelings about language brokering for their mothers (Kim, Hou, Shen, et al., 2017). A sample item from the four-item *efficacy* subscale ($\alpha = .85$) is “I am skilled at translating for my mother”; a sample item for the three-item *parental dependence* subscale ($\alpha = .58$) is “My mother is not in control of the situation when she asks me to translate.” These two subscales were found to be invariant across adolescent gender, nativity, and translation frequency, and had previously shown predictive validity with adolescent depressive symptoms in a Mexican American sample (Kim, Hou, Shen, et al., 2017).

Covariates—Adolescents reported their gender (0 = *male*, 1 = *female*), nativity (0 = *Mexico-born*, 1 = *U.S.-born*), translation frequency for their mother (1 = *A few times a year*, 2 = *A few times every 3 to 6 months*, 3 = *A few times a month*, 4 = *A few times a week*, 5 = *Daily*), and their proficiency in English and Spanish. Adolescent proficiency in English ($\alpha = .75$) and Spanish ($\alpha = .82$) were measured by calculating the mean of their reading, writing, speaking, and understanding English and Spanish (1 = *not well* to 5 = *extremely well*). They also reported on behaviors known to relate to cortisol levels, including caffeine and alcohol consumption within 12 hours of the visit, as well as general smoking, nicotine, and medication use (0 = *No*, 1 = *Yes*). Mothers answered questions on family income and their highest education level. Family income was assessed in \$10,000 increments using an 11-point scale, ranging from “1 = *\$10,000 or under*” to “11 = *\$110,001 or more*.” Mothers reported their highest education level on a 11-point scale ranging from “1 = *no formal schooling*” to “11 = *completed a graduate degree*.”

Results

Analytical Strategy

A two-level multilevel model¹ was estimated via PROC MIXED in SAS 9.3 (SAS Institute, 2011) to examine cortisol response across seven time points and the moderating effect of

¹We also conducted analyses using a simplified alternative model to address concerns that may arise about using a complex modeling strategy on a small sample. Using Mplus 7.4, we selected the four moderators (i.e., daily discrimination, maternal hostility, language brokering efficacy, and language brokering parental dependence) in the multilevel model and examined them as the predictors of three regression models. The outcome variables of the regression models were: 1) *baseline cortisol*, 2) *cortisol response mean* (mean of cortisol levels at the anticipatory phase, acute stress phase, and after completion of the tasks, controlling for baseline cortisol); 3) *cortisol recovery mean* (mean of cortisol levels at recovery phases 1, 2, and 3, controlling for baseline cortisol and the response mean). Results indicated that, for Model 1 (baseline cortisol as outcome), *language brokering efficacy for mother* was negatively associated with baseline cortisol ($\beta = -0.426, p = .007$), while *language brokering maternal dependence* was positively associated with *baseline cortisol* ($\beta = 0.515, p = .002$). The overall R^2 for Model 1 was 19.4% ($p = .064$). For Model 2 (cortisol response as outcome), *daily discrimination* ($\beta = -0.321, p = .015$) and *language brokering parental dependence* ($\beta = -0.223, p = .024$) were negatively associated with the *response mean*, controlling for baseline cortisol. The positive association between *language brokering efficacy for mother* and

adolescents' discrimination experiences, perceived maternal hostility, and perception (positive or negative) of their language brokering experience. The log-transformed cortisol data were first plotted. Cortisol values across the visit appeared to be non-linear; thus, the within-individual level modeled each participant's cortisol reactivity and recovery as a function of time (coding of time variables: 0.5 represents 5 minutes) and the quadratic of time as follows:

$$\text{Cortisol}_{ij} = \beta_{0i} + \beta_{1i}\text{Time}_{ij} + \beta_{2i}\text{Time}_{ij}^2 + e_{ij}$$

The between-individual level estimated the random effects for the within-individual variables and tested whether adolescents' cortisol levels varied as a function of *discrimination experiences*, *perceived maternal hostility*, and their sense of *language brokering efficacy* and *parental dependence*:

$$\begin{aligned}\beta_{0i} &= \gamma_{00} + \gamma_{01}\text{Discrimination}_i + \gamma_{02}\text{Hostility}_i + \gamma_{03}\text{Efficacy}_i + \gamma_{04}\text{Dependence}_i (\gamma_{05,6,7\dots}\text{Covariates}_i) + u_{1i} \\ \beta_{1i} &= \gamma_{10} + \gamma_{11}\text{Discrimination}_i + \gamma_{12}\text{Hostility}_i + \gamma_{13}\text{Efficacy}_i + \gamma_{14}\text{Dependence}_i + u_{1i} \\ \beta_{2i} &= \gamma_{20} + \gamma_{21}\text{Discrimination}_i + \gamma_{22}\text{Hostility}_i + \gamma_{23}\text{Efficacy}_i + \gamma_{24}\text{Dependence}_i + u_{1i}\end{aligned}$$

As none of the coefficients of the tested covariates (i.e., adolescent gender, nativity, translating frequency, English proficiency, Spanish proficiency, family income, mother's highest education level, caffeine and alcohol consumption, smoking, nicotine use, and medication use) were significant, all were dropped from the final model.

Analytic Results

Descriptive information on the study variables is presented in Table 2. Results of the within-individual model (Table 3, Model 1) showed that coefficients for intercept, linear term (time) and quadratic term (time²) were significant, suggesting that, as hypothesized, the adapted TSST effectively triggered the acute stress response in adolescents. The moderation analyses revealed that the linear change in cortisol levels interacted with *discrimination*, sense of *efficacy*, and *parental dependence*; and the quadratic change in cortisol levels interacted with *maternal hostility*, sense of *efficacy*, and *parental dependence* (Table 3, Model 2).

Simple slope analysis (Figure 1) showed that relative to adolescents with higher scores on *discrimination*, those with lower *discrimination* scores exhibited a steeper response to the acute stressor over the course of the TSST (+1SD: $\beta_{\text{intercept}} = 0.410$, $p = .045$, $\beta_{\text{time}} = 0.046$, $p = .305$, $\beta_{\text{time}^2} = -0.014$, $p < .001$; -1SD: $\beta_{\text{intercept}} = 0.257$, $p = .209$, $\beta_{\text{time}} = 0.192$, $p < .001$, $\beta_{\text{time}^2} = -0.022$, $p < .001$; Figure 1a). Relative to adolescents with higher scores on

cortisol response mean was marginal ($\beta = 0.234$, $p = .052$). The R² of the stress response mean explained by the variables of interest (four predictors) was 11.4%. For Model 3 (cortisol recovery as outcome), *maternal hostility* was positively associated with *cortisol recovery mean* ($\beta = 0.164$, $p = .015$), controlling for baseline cortisol and cortisol response mean. The R² of the stress recovery mean explained by the variables of interest (four predictors) was 3.1%.

Results of the regression models replicated results in the multilevel model, in that adolescents with lower *daily discrimination* scores exhibited a steeper response to the acute stressor; and higher *perceived maternal hostility* scores showed elevated levels in cortisol recovery from the acute stressor. Furthermore, adolescents with higher scores on *language brokering efficacy* demonstrated lower baseline stress and (marginally) steeper stress responses, and adolescents with lower *language brokering parental dependence* demonstrated lower baseline stress and greater response to the stressor, both of which replicated results in our multilevel model.

perceived maternal hostility, those with lower *perceived maternal hostility* scores exhibited faster recovery from the acute stressor (+1SD: $\beta_{intercept} = 0.392, p = .107, \beta_{time} = 0.083, p = .071, \beta_{time}^2 = -0.013, p < .001$; -1SD: $\beta_{intercept} = 0.339, p = .097, \beta_{time} = 0.155, p = .001, \beta_{time}^2 = -0.023, p < .001$; Figure 1b).

Moreover, relative to adolescents with lower ratings of language brokering *efficacy*, those with higher ratings of *efficacy* demonstrated lower baseline stress and steeper responses to the stressor, with faster recovery (+1SD: $\beta_{intercept} = -0.067, p = .759, \beta_{time} = 0.231, p < .001, \beta_{time}^2 = -0.026, p < .001$; -1SD: $\beta_{intercept} = 0.735, p = .002, \beta_{time} = 0.007, p = .894, \beta_{time}^2 = -0.009, p = .016$; Figure 1c). Finally, relative to adolescents with higher ratings of language brokering *parental dependence*, those with lower ratings of *parental dependence* exhibited lower baseline stress and greater response to the stressor, with faster recovery (+1SD: $\beta_{intercept} = 0.819, p = .001, \beta_{time} = -0.016, p = .757, \beta_{time}^2 = -0.009, p = .032$; -1SD: $\beta_{intercept} = -0.151, p = .510, \beta_{time} = 0.254, p < .001, \beta_{time}^2 = -0.027, p < .001$; Figure 1d).

Discussion

Language brokering is a salient experience for many Mexican American youth. The process of translation may be stressful in some situations (Kam & Lazarevic, 2014b); however, no study to date has documented the physiological ramifications for children, nor considered the complexity of children's experiences of translating—namely, that individual and contextual factors may play a role in acute stress related to translating. Using translation and arithmetic tasks modeled after the TSST, we examined Mexican American adolescents' cortisol responses to completing these tasks, and examined whether their acute stress responses varied by the individuals' perception of language brokering (i.e., efficacy and parental dependence), familial factors (i.e., maternal hostility), and discrimination experiences. Results revealed that, on average, the medical translation and arithmetic tasks did evoke a stress response in adolescents. Their responses, however, varied according to individual, family, and environmental factors. Our findings highlight the importance of examining Mexican American adolescents' own feelings about language brokering, and the larger contexts in which their experiences occur, when attempting to understand the nuances of their acute stress responses, especially in cases where translation is a component of the acute stressor.

Our findings revealed that discrimination and parent-child hostility moderated adolescents' responses to the language brokering task. For discrimination, youth who reported low levels of discrimination (relative to their peers) exhibited the expected HPA axis response to the task: they had a significant rise in cortisol level after baseline. Those who reported high levels of discrimination, however, showed no physiological response to the task. Our findings are in line with prior work examining the effects of discrimination on acute reactivity (Lucas, Wegner, et al., 2017) and may be explained by the physiological differences in HPA axis activity in those who are under chronic stress versus those who are not (Miller et al., 2007). Adolescents who are experiencing high levels of discrimination may not react physiologically to the acute stressor because they are under chronic stress, and thus exhibit altered HPA axis functioning (Lopez-Duran, Kovacs, & George, 2009; Miller et

al., 2007). Specifically, chronic stress is theorized to contribute to dysregulation of the feedback mechanisms of the HPA axis, resulting in lower reactivity during an acute stressor (hypocortisolism; Gunnar & Vazquez, 2001). The lack of physiological response among those who reported high levels of discrimination may suggest that language brokering may be particularly burdensome for those who are already chronically stressed. This finding warrants close attention in future research, given that blunted HPA axis activity has been linked to adolescent mental health problems (Booij, Bouma, de Jonge, Ormel, & Oldehinkel, 2013).

Another, albeit less plausible, explanation focuses on the *psychological* differences between individuals: perhaps, those who are experiencing high levels of discrimination did not find our acute stressor to be stressful in light of the difficulties they are facing related to mistreatment. In other words, our modified stressor may not seem as stressful to them as the other sources of stress they are experiencing, and thus an acute response was not seen.

As for the parent-child relationship factors, findings demonstrated that after the acute stressor, adolescents who reported high levels of maternal hostility demonstrated a slower decline in cortisol levels compared to children who reported low levels of hostility. Note, however, that no differences were seen in cortisol levels before the stressor, at baseline. Given that children translated the document for their mother, it could be that interactions between the parent and child particularly mattered in how quickly adolescents recovered after the task. Those reporting low hostility quickly recovered after the task; those reporting more hostility remained physiologically activated for a longer period. The recovery period may have been influenced by parent-child interactions after the stressor (that may not have been evident before the stressor). That is, within families with greater maternal hostility, mothers may provide less support or reassurance after a stressful task. Our findings provide further evidence that parent-child relationship factors are relevant when researching the impact of acute stressors on children's well-being (Hostinar et al., 2015; Luecken & Appelhans, 2006; Marsman et al., 2012). Youth who have positive relationships with parents may indeed feel the acute stressor physiologically, but the effects are likely short-lived. Youth with strained relationships with parents may experience more long-term stress reactivity due to the acute stressor.

We also examined the role of adolescents' perceptions during language brokering, focusing on efficacy and perceptions of parental dependence. Findings suggested that adolescents who felt efficacious, and/or reported low parental dependence, demonstrated an expected stress response to the acute stressor: low levels at the start of the task, a steep increase after the task, and a steep recovery. Adolescents who did not feel efficacious or who reported high parental dependence, however, exhibited significantly higher levels of cortisol at the start of the acute stressor, did not exhibit a change in cortisol after the task, and had a slower recovery.

One explanation for these findings could center on the anticipation of the translation task as a component of the acute stressor. Adolescents and parents were informed about the task by research personnel in advance. Although the translation task was conducted in subjects' homes (which would be considered a relatively safe and comfortable environment), knowing

that a translation task was approaching could have evoked a heightened sense of stress and anxiety, particularly for those who reported low *efficacy* and high *parental dependence* related to translating. These adolescents were the ones who exhibited a heightened cortisol response even before the acute stressor task began. The same response was not exhibited by efficacious brokers, or by those who reported low parental dependence, possibly because they may have felt confident in their translation abilities and/or less burdened by an acute stressor involving translation. For parental dependence specifically, our findings may reflect a sense of reliance on children, and in some instances ‘parentification’, in which adolescents are put in a position in which their parent is reliant upon them. We interpret these findings with caution, however, given that the parental dependence scale demonstrated relatively low reliability in the current study. Replication of findings is needed for a more robust conclusion.

Our study is the first empirical study to document a link between the acute response of the HPA axis and Mexican American adolescents’ translation stress. Taken together, our findings suggest that physiological stress is associated with an acute stressor that involves early adolescents language brokering a medically-oriented document; however, the nature of this stress response is largely dependent upon individual, familial, and environmental factors. Youth who experience little discriminatory stress, report low maternal hostility, and feel more positive about their language brokering experience respond with a heightened sense of stress evoked by our modified acute stressor, but this stress is short-lived and adolescents recover quickly. Such an adaptive response and recovery to our modified acute stressor may go hand-in-hand with other positive outcomes that have been documented in the literature on language brokers (i.e., enhanced metalinguistic abilities, stronger interpersonal skills; Malakoff & Hakuta, 1991; Valdés, 2003). On the other hand, adolescents who experience high levels of discriminatory stress or strained relationships with parents may be more negatively impacted by language brokering in the long term and, therefore, may be at risk for negative outcomes (i.e., acculturation stress, depression, anxiety; Kam, Marcoulides, & Merolla, 2017; Kim, Hou, & Gonzalez, 2017). Future studies exploring the long-term implications of language brokering as they relate to individual perceptions, familial relationships, and environmental stressors are needed to help uncover the complexities of language brokering during developmentally salient times.

Despite the strengths of the current study, there are some limitations worth noting. First, we had a small sample of adolescents, which could limit the statistical power and effect sizes of the current study. Future studies examining larger samples of language brokers and their acute responses are needed. Second, the structured translation task and self-report assessments used in the current study may limit the generalizability of our findings. Indeed, language brokering occurs in numerous contexts and involves a wide range of content (Kam & Lazarevic, 2014a). Thus, translating a medically-oriented document in a controlled setting (in the home, observed by study personnel) may not adequately capture how translation processes play out in different contexts (e.g., at a bank or grocery store) or when translation occurs for different content (e.g., ordering at a restaurant). Relatedly, we adapted the TSST by changing the speech task to a translation task; we retained all other aspects of the test, including the arithmetic task. However, that choice prevented us from isolating the effect of language brokering from the stress of the arithmetic task, as our acute stressor involved both

types of tasks. Finally, we relied upon adolescents' self-reports of efficacy, dependability, and language proficiency (control variable). Although it is critical to capture adolescents' perceptions, it may be equally important to include objective assessments of translation quality, language proficiency, and parent-child relationship dynamics. A fruitful avenue for future research would be examining language brokering across multiple contexts, with both subjective and objective indicators of language brokering, ideally with stronger reliability for measures of parental dependence.

We encourage continued research into the complexities of language brokering, and suggest that future studies pay attention to adolescents' own perceptions, their family relationships, and the contextual demands that simultaneously occur when faced with acute stressors, such as translating, in their daily lives. It is only when these factors are considered together that we will have a clearer understanding of both the benefits and the risks of the language brokering experience.

Acknowledgments

Support for this research was provided through awards to Su Yeong Kim from (1) National Science Foundation, Division of Behavioral and Cognitive Sciences, 1651128 and 0956123 (2) Eunice Kennedy Shriver National Institute of Child Health and Human Development 5R03HD060045-02 (3) Office of the Vice President for Research and Creative Grant and Special Research Grant from the University of Texas at Austin, and (4) Eunice Kennedy Shriver National Institute of Child Health and Human Development 2P2CHD042849-16 grant awarded to the Population Research Center at The University of Texas at Austin.

References

- Allen AP, Kennedy PJ, Dockray S, Cryan JF, Dinan TG, Clarke G. The Trier Social Stress Test: Principles and practice. *Neurobiology of Stress*. 2017; 6:113–126. DOI: 10.1016/j.ynstr.2016.11.001 [PubMed: 28229114]
- Anderson NB. Levels of analysis in health science: A framework for integrating sociobehavioral and biomedical research. In: McCann SM, Lipton JM, Sternberg EM, Chrousos GP, Gold PW, Smith CC, editors *Molecular aspects, integrative systems, and clinical advances*. Vol. 840. New York, NY: New York Academy of Sciences; 1998. 563–576.
- Berger M, Sarnyai Z. 'More than skin deep': Stress neurobiology and mental health consequences of racial discrimination. *Stress: The International Journal on the Biology of Stress*. 2015; 18:1–10. DOI: 10.3109/10253890.2014.989204
- Booij SH, Bouma EMC, de Jonge P, Ormel J, Oldehinkel AJ. Chronicity of depressive problems and the cortisol response to psychosocial stress in adolescents: The TRAILS study. *Psychoneuroendocrinology*. 2013; 38:659–666. DOI: 10.1016/j.psyneuen.2012.08.004 [PubMed: 22963816]
- Bronfenbrenner U, Morris PA. The bioecological model of human development. In: Lerner RM, Damon W, editors *Handbook of child psychology (6th ed.): Vol 1, Theoretical models of human development*. Hoboken, NJ, US: John Wiley & Sons Inc; 2006. 793–828.
- Busse D, Yim IS, Campos B. Social context matters: Ethnicity, discrimination and stress reactivity. *Psychoneuroendocrinology*. 2017; 83:187–193. DOI: 10.1016/j.psyneuen.2017.05.025 [PubMed: 28646798]
- Chao RK. The prevalence and consequences of adolescents' language brokering for their immigrant parents. In: Bornstein MH, Cote LR, editors *Acculturation and parent-child relationships: Measurement and development*. Mahwah, NJ: Erlbaum; 2006. 271–296.
- Chithambo TP, Huey SJ Jr, Cespedes-Knadle Y. Perceived discrimination and Latino youth adjustment: Examining the role of relinquished control and sociocultural influences. *Journal of Latina/o Psychology*. 2014; 2:54–66. DOI: 10.1037/lat0000012

- Chrousos GP, Gold PW. The concepts of stress and stress system disorders: Overview of physical and behavioral homeostasis. *JAMA*. 1992; 267:1244–1252. DOI: 10.1001/jama.1992.03480090092034 [PubMed: 1538563]
- Dickerson SS, Kemeny ME. Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*. 2004; 130:355–391. DOI: 10.1037/0033-2909.130.3.355 [PubMed: 15122924]
- Doane LD, Zeiders KH. Contextual moderators of momentary cortisol and negative affect in adolescents' daily lives. *Journal of Adolescent Health*. 2014; 54:536–542. DOI: 10.1016/j.jadohealth.2013.10.007 [PubMed: 24321894]
- Dorner LM, Orellana MF, Jiménez R. 'It's one of those things that you do to help the family': Language brokering and the development of immigrant adolescents. *Journal of Adolescent Research*. 2008; 23:515–543. DOI: 10.1177/0743558408317563
- Dressendorfer R, Kirschbaum C, Rohde W, Stahl F, Strasburger C. Synthesis of a cortisol-biotin conjugate and evaluation as a tracer in an immunoassay for salivary cortisol measurement. *Journal of Steroid Biochemistry and Molecular Biology*. 1992; 43:683–692. DOI: 10.1016/0960-0760(92)90294-S [PubMed: 1472460]
- Fuligni AJ, Telzer EH, Bower J, Irwin MR, Kiang L, Cole SW. Daily family assistance and inflammation among adolescents from Latin American and European backgrounds. *Brain, Behavior, and Immunity*. 2009; 23:803–809. DOI: 10.1016/j.bbi.2009.02.021
- Ge X, Best KM, Conger RD, Simons RL. Parenting behaviors and the occurrence and co-occurrence of adolescent depressive symptoms and conduct problems. *Developmental Psychology*. 1996; 32:717–731. DOI: 10.1037/0012-1649.32.4.717
- Gunnar MR, Vazquez DM. Low cortisol and a flattening of expected daytime rhythm: Potential indices of risk in human development. *Development and Psychopathology*. 2001; 13:515–538. DOI: 10.1017/S0954579401003066 [PubMed: 11523846]
- Hostinar CE, Johnson AE, Gunnar MR. Parent support is less effective in buffering cortisol stress reactivity for adolescents compared to children. *Developmental Science*. 2015; 18:281–297. DOI: 10.1111/desc.12195 [PubMed: 24942038]
- Kam JA. The effects of language brokering frequency and feelings on Mexican-heritage youth's mental health and risky behaviors. *Journal of Communication*. 2011; 61:455–475. DOI: 10.1111/j.1460-2466.2011.01552.x
- Kam JA, Lazarevic V. Communicating for one's family: An interdisciplinary review of language and cultural brokering in immigrant families. In: Cohen EL, editor *Communication Yearbook 38*. New York: Routledge; 2014a. 3–38.
- Kam JA, Lazarevic V. The stressful (and not so stressful) nature of language brokering: Identifying when brokering functions as a cultural stressor for Latino immigrant children in early adolescence. *Journal of Youth and Adolescence*. 2014b; 43:1994–2011. DOI: 10.1007/s10964-013-0061-z [PubMed: 24241786]
- Kam JA, Marcoulides KM, Merolla AJ. Using an acculturation-stress-resilience framework to explore latent profiles of latina/o language brokers. *Journal of Research on Adolescence*. 2017; doi: 10.1111/jora.12318
- Katz V. Children as brokers of their immigrant families' health-care connections. *Social Problems*. 2014; 61:194–215. DOI: 10.1525/sp.2014.12026
- Kessler RC, Mickelson KD, Williams DR. The prevalence, distribution, and mental health correlates of perceived discrimination in the United States. *Journal of Health and Social Behavior*. 1999; 40:208–230. DOI: 10.2307/2676349 [PubMed: 10513145]
- Kim SY, Hou Y, Gonzalez Y. Language brokering and depressive symptoms in Mexican American adolescents: Parent-child alienation and resilience as moderators. *Child Development*. 2017; 88:867–881. DOI: 10.1111/cdev.12620 [PubMed: 27637380]
- Kim SY, Hou Y, Shen Y, Zhang M. Longitudinal measurement equivalence of subjective language brokering experiences for mothers and fathers in Mexican American adolescents. *Cultural Diversity & Ethnic Minority Psychology*. 2017; 23:230–243. DOI: 10.1037/cdp0000117 [PubMed: 27362872]

- Kirschbaum C, Pirke KM, Hellhammer DH. The 'Trier Social Stress Test': A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology*. 1993; 28:76–81. DOI: 10.1159/000119004 [PubMed: 8255414]
- Kudielka BM, Bellingrath S, Hellhammer DH. Cortisol in burnout and vital exhaustion: An overview. *Giornale Italiano di Medicina del Lavoro ed Ergonomia*. 2006; 28:34–42.
- Kudielka BM, Hellhammer DH, Kirschbaum C. Ten years of research with the Trier Social Stress Test- Revisited. In: Harmon-Jones E, Winkelman P, editors *Social neuroscience: Integrating biological and psychological explanations of social behavior*. New York: Guilford Press; 2007. 56–83.
- Kudielka BM, Hellhammer DH, Wüst S. Why do we respond so differently? Reviewing determinants of human salivary cortisol responses to challenge. *Psychoneuroendocrinology*. 2009; 34:2–18. DOI: 10.1016/j.psyneuen.2008.10.004 [PubMed: 19041187]
- Lopez-Duran NL, Kovacs M, George CJ. Hypothalamic-pituitary-adrenal axis dysregulation in depressed children and adolescents: A meta-analysis. *Psychoneuroendocrinology*. 2009; 34:1272–1283. DOI: 10.1016/j.psyneuen.2009.03.016 [PubMed: 19406581]
- Lovallo WR. *Stress and health: Biological and psychological interactions*. 3. Thousand Oaks, CA: Sage; 2016.
- Love JA, Buriel R. Language brokering, autonomy, parent-child bonding, biculturalism, and depression: A study of Mexican American adolescents from immigrant families. *Hispanic Journal of Behavioral Sciences*. 2007; 29:472–491. DOI: 10.1177/0739986307307229
- Lucas T, Pierce J, Lumley MA, Granger DA, Lin J, Epel ES. Telomere length and procedural justice predict stress reactivity responses to unfair outcomes in African Americans. *Psychoneuroendocrinology*. 2017; 86:104–109. DOI: 10.1016/j.psyneuen.2017.09.008 [PubMed: 28938175]
- Lucas T, Wegner R, Pierce J, Lumley MA, Laurent HK, Granger DA. Perceived discrimination, racial identity, and multisystem stress response to social evaluative threat among African American men and women. *Psychosomatic Medicine*. 2017; 79:293–305. DOI: 10.1097/psy.0000000000000406 [PubMed: 27806018]
- Luecken LJ, Appelhans BM. Early parental loss and salivary cortisol in young adulthood: The moderating role of family environment. *Development and Psychopathology*. 2006; 18:295–308. DOI: 10.1017/S0954579406060160 [PubMed: 16478564]
- Malakoff ME, Hakuta K. Translation skill and metalinguistic awareness in bilinguals. In: Bialystok E, editor *Language processing in bilingual children*. New York, NY: Cambridge University Press; 1991. 141–166.
- Marsman R, Nederhof E, Rosmalen JGM, Oldehinkel AJ, Ormel J, Buitelaar JK. Family environment is associated with HPA-axis activity in adolescents. The TRAILS study. *Biological Psychology*. 2012; 89:460–466. DOI: 10.1016/j.biopsycho.2011.12.013 [PubMed: 22212280]
- Martinez CR Jr, McClure HH, Eddy JM. Language brokering contexts and behavioral and emotional adjustment among Latino parents and adolescents. *The Journal of Early Adolescence*. 2009; 29:71–98. DOI: 10.1177/0272431608324477 [PubMed: 19898605]
- Martinez CR, McClure HH, Eddy JM, Wilson DM. Time in U.S. residency and the social, behavioral, and emotional adjustment of Latino immigrant families. *Hispanic Journal of Behavioral Sciences*. 2011; 33:323–349. DOI: 10.1177/0739986311411281
- McEwen BS. Stress, adaptation, and disease: Allostasis and allostatic load. In: McCann SM, Lipton JM, Sternberg EM, Chrousos GP, Gold PW, Smith CC, editors *Molecular aspects, integrative systems, and clinical advances*. Vol. 840. New York, NY, US: New York Academy of Sciences; 1998. 33–44.
- McEwen BS. Sex, stress and the hippocampus: Allostasis, allostatic load and the aging process. *Neurobiology of Aging*. 2002; 23:921–939. DOI: 10.1016/s0197-4580(02)00027-1 [PubMed: 12392796]
- McGue M, Elkins I, Walden B, Iacono WG. Perceptions of the parent-adolescent relationship: A longitudinal investigation. *Developmental Psychology*. 2005; 41:971–984. DOI: 10.1037/0012-1649.41.6.971 [PubMed: 16351340]

- McQuillan J, Tse L. Child language brokering in linguistic minority communities: Effects on cultural interaction, cognition, and literacy. *Language and Education*. 1995; 9:195–215. DOI: 10.1080/09500789509541413
- Miller GE, Chen E, Zhou ES. If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological Bulletin*. 2007; 133:25–45. DOI: 10.1037/0033-2909.133.1.25 [PubMed: 17201569]
- Nash A. Arab Americans' brokering in a context of tension and stereotypes. In: Weisskirch RS, editor *Language brokering in immigrant families: Theories and contexts*. New York, NY: Taylor & Francis; 2017.
- Nierop A, Wirtz PH, Bratsikas A, Zimmermann R, Ehlert U. Stress-buffering effects of psychosocial resources on physiological and psychological stress response in pregnant women. *Biological Psychology*. 2008; 78:261–268. DOI: 10.1016/j.biopsycho.2008.03.012 [PubMed: 18462859]
- O'Leary A. Self-efficacy and health: Behavioral and stress-physiological mediation. *Cognitive Therapy and Research*. 1992; 16:229–245. DOI: 10.1007/BF01173490
- Orellana MF, Dorner L, Pulido L. Accessing Assets: Immigrant Youth's Work as Family Translators or "Para-Phrasers". *Social Problems*. 2003; 50:505–524. DOI: 10.1525/sp.2003.50.4.505
- Prado G, Pantin H. Reducing substance use and HIV health disparities among Hispanic youth in the U.S.A.: The familias Unidas program of research. *Intervencion psicosocial*. 2011; 20:63–73. DOI: 10.5093/in2011v20n1a6 [PubMed: 21743790]
- SAS Institute. *SAS/STAT® 9.3 user's guide*. Cary, NC: SAS institute; 2011.
- Spies LA, Margolin G, Susman EJ, Gordis EB. Adolescents' cortisol reactivity and subjective distress in response to family conflict: The moderating role of internalizing symptoms. *Journal of Adolescent Health*. 2011; 49:386–392. DOI: 10.1016/j.jadohealth.2011.01.014 [PubMed: 21939869]
- Stein JA, Rotheram-Borus MJ, Lester P. Impact of parentification on long-term outcomes among children of parents with HIV/AIDS. *Family Process*. 2007; 46:317–333. DOI: 10.1111/j.1545-5300.2007.00214.x [PubMed: 17899856]
- Stokols D. Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion*. 1996; 10:282–298. DOI: 10.4278/0890-1171-10.4.282 [PubMed: 10159709]
- Sturge-Apple ML, Davies PT, Cicchetti D, Manning LG. Interparental violence, maternal emotional unavailability and children's cortisol functioning in family contexts. *Developmental Psychology*. 2012; 48:237–249. DOI: 10.1037/a0025419 [PubMed: 21967568]
- Taylor S. The future of social-health psychology: Prospects and predictions. *Social and Personality Psychology Compass*. 2011; 5:275–284. DOI: 10.1111/j.1751-9004.2011.00360.x
- Tse L. Language brokering among Latino adolescents: Prevalence, attitudes, and school performance. *Hispanic Journal of Behavioral Sciences*. 1995; 17:180–193. DOI: 10.1177/07399863950172003
- Valdés G. *Expanding definitions of giftedness: The case of young interpreters from immigrant communities*. Mahwah, NJ: Erlbaum; 2003.
- Wagner JA, Tennen H, Finan PH, Ghuman N, Burg MM. Self-reported racial discrimination and endothelial reactivity to acute stress in women. *Stress and Health: Journal of the International Society for the Investigation of Stress*. 2013; 29:214–221. DOI: 10.1002/smi.2449 [PubMed: 22962001]
- Weisskirch RS. Feelings about language brokering and family relations among Mexican American early adolescents. *The Journal of Early Adolescence*. 2007; 27:545–561. DOI: 10.1177/0272431607302935
- Wiedenfeld SA, O'Leary A, Bandura A, Brown S, Levine S, Raska K. Impact of perceived self-efficacy in coping with stressors on components of the immune system. *Journal of Personality and Social Psychology*. 1990; 59:1082–1094. DOI: 10.1037/0022-3514.59.5.1082 [PubMed: 2148350]
- Wu NH, Kim SY. Chinese American adolescents' perceptions of the language brokering experience as a sense of burden and sense of efficacy. *Journal of Youth and Adolescence*. 2009; 38:703–718. DOI: 10.1007/s10964-008-9379-3 [PubMed: 19636765]

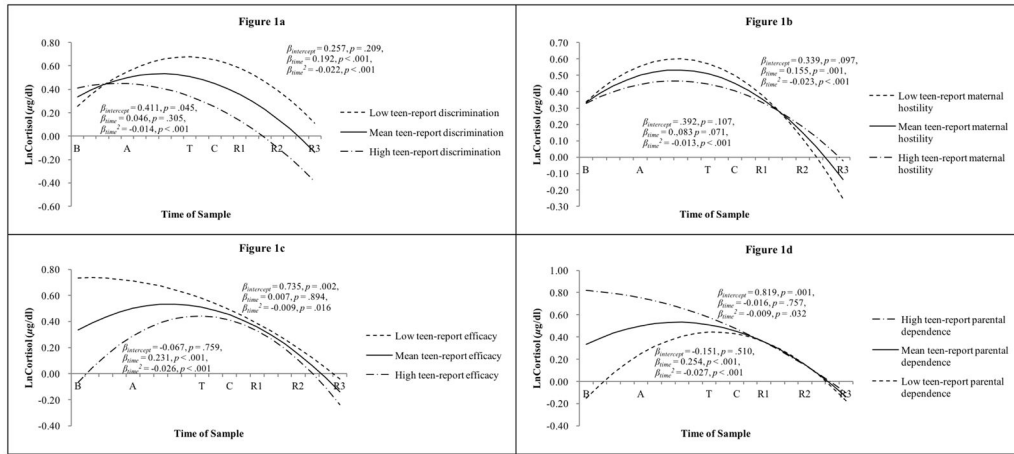


Figure 1. Model 1: Log-transformed cortisol level at each time point moderated by teen-reported global assessment of perceived discrimination (upper left, a), maternal hostility (upper right, b), and their sense of efficacy (lower left, c) and parental dependence (lower right, d) when language brokering for mother at high (+1 SD), mean, and low (−1 SD) levels. The x-axis refers to the time point of each event (e.g., base, anticipation, etc.), which occurred 15 minutes before the corresponding salivary cortisol samples were collected across the procedure. Base = Baseline; Antic = Anticipatory phase; Translate = Acute stress phase involving translation and arithmetic tasks; Complete = Completion of translation and arithmetic tasks; R1 = Recovery 1; R2 = Recovery 2; R3 = Recovery 3.

Details (measured time points, time interval, and coding) of seven salivary cortisol samples collected.

Table 1

	Target cortisol measured	Real time interval (unit: minutes)	Coding (for analysis)
1	Baseline	0	0
2	Anticipatory Phase	20	2
3	Acute Stress Phase (include translation task and arithmetic task)	45	4.5
4	Completion of the Tasks	55	5.5
5	Recovery 1	65	6.5
6	Recovery 2	80	8
7	Recovery 3	95	9.5

Note. Each saliva sample was collected 15 minutes after the cortisol level it was meant to measure, as it takes cortisol approximately 15 minutes to enter an individual's saliva.

Table 2

Descriptive table of the studied variables.

	Discrimination	Maternal Hostility	Efficacy	Language Brokering			Raw Cortisol						
				Parental Dependence	B	A	T	C	R1	R2	R3		
<i>N</i>	46	46	46	46	46	46	44	44	44	44	44	44	43
Missing	0	0	0	0	0	0	2	2	2	2	2	2	3
<i>Mean</i>	1.51	2.71	3.23	2.83	1.82	2.42	2.56	2.42	2.17	1.73	1.73	1.41	1.41
<i>SD</i>	0.512	1.094	0.597	0.726	1.558	1.605	1.790	1.488	1.325	0.965	0.965	0.950	0.950

Note. B = Baseline; A = Anticipatory phase; T = Acute stress phase involving translation and arithmetic tasks; C = Completion of translation and arithmetic tasks; R1 = Recovery 1; R2 = Recovery 2; R3 = Recovery 3.

Table 3 Within-individual model assessing cortisol levels during an acute stressor and multilevel random-effects model assessing cortisol levels during an acute stressor as a function of adolescents' discrimination, maternal hostility, sense of efficacy, and parental dependence

Predictor	Model 1				Model 2			
	Coefficient	SE	t	p <	Coefficient	SE	t	p <
Intercept	0.333	0.142	2.34	0.024*	0.334	0.135	2.47	0.018*
Time	0.121	0.036	3.35	0.002**	0.119	0.03	3.94	<0.001***
Time ²	-0.018	0.003	-6.44	<.001***	-0.018	0.002	-7.72	<0.001***
Daily Discrimination					0.152	0.29	0.52	0.603
Maternal Hostility					-0.004	0.135	-0.03	0.974
Efficacy					-0.668	0.285	-2.35	0.023*
Parental Dependence					0.664	0.249	2.66	0.011*
Daily Discrimination × Time					-0.143	0.064	-2.22	0.032*
Maternal Hostility × Time					-0.033	0.03	-1.09	0.283
Efficacy × Time					0.187	0.063	2.96	0.005***
Parental Dependence × Time					-0.184	0.055	-3.33	0.002***
Daily Discrimination × Time ²					0.008	0.005	1.63	0.11
Maternal Hostility × Time ²					0.005	0.002	2.04	0.048*
Efficacy × Time ²					-0.014	0.005	-2.95	0.005***
Parental Dependence × Time ²					0.013	0.004	2.98	0.005***

Note. Discrimination, maternal hostility, efficacy, and parental dependence are grand-mean centered.

* $p < .05$,

** $p < .01$,

*** $p < .001$.