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Acute Salivary Cortisol Response Among Mexican American Adolescents in Immigrant Families

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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 has revealed a somewhat mixed picture: Some evidence has suggested 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 have pointed 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 has suggested that examining factors unilaterally (attending to only psychological or only socioenvironmental 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 more 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 involving the hypothalamus, the pituitary gland, and the adrenal cortex occurs, 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 among 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 next.

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 have suggested 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, & Zhang, 2017). Feeling efficacious about the translating activity can potentially improve adolescents' physiology, leading to more adaptive stress responses. Indeed, past research has suggested 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 area under the curve (AUC) approach, Nierop, Wirtz, Bratsikas, Zimmermann, 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, p. 317), has suggested that language brokering may lead to greater parental reliance on children. High levels of perceived parental dependence may reflect this overreliance 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 (Fulgini 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 has posited 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, one may observe hyporesponsivity to the TSST, because prior research has found dampened stress responses among chronically burdened participants (Kudielka, Bellingrath, & Hellhammer, 2006). Specifically, chronic stressors have been 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, one 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 has suggested that adverse familial environments (e.g., conflict in family of origin) are associated with heightened acute stress reactivity (Luecken & Appelhans, 2006). Spies and colleagues (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). Because past research has shown 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 therefore postulated that for adolescent language brokers who are situated in inimical familial contexts, hostile parent-child relationships 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 has shown a robust relation to heightened acute stress responses and diminished physical health is discrimination (Berger & Sarnyai, 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, Wegner, 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 has been 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-subject cortisol activity. In particular, in high-discrimination contexts, negative affect was found to relate to greater within-subject 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 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 the following:

Hypothesis 1: 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 the following:

Hypothesis 2a: Language brokers with high levels of language-brokering efficacy will have low baseline stress levels, steeper stress reactivity, and faster recovery patterns.

Hypothesis 2b: Language brokers with high levels of parental dependence will 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 hyporesponsivity 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.

Hypothesis 2c: Language brokers who report high levels of parental hostility will have high baseline cortisol levels, less steep stress reactivity, and slower recovery.

For discrimination, we hypothesized that language brokers who report lower levels of discrimination will 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 hyporeactivity theory (Kudielka et al., 2006, 2009), such that

Hypothesis 2d: Language brokers experiencing high levels of discrimination will 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 of 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 ($SD = .43$, range = 11–13), and the majority (73.9%) were U.S.-born.

The average number of years of living in the United States 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–\$40,000 or less.

Procedure

Adolescents completed a modified Trier Social Stress Test (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’s 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 min 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.

Table 1
Time Points, Time Interval, and Coding of Salivary Cortisol Samples Collected

| Time point | Cortisol level measured | Real-time interval (in min) | Coding (for analysis) |
|---|--|-----------------------------|-----------------------|
| Baseline | 5 min prior to research assistants’ arrival | 0 | 0 |
| Anticipatory phase | Right after the participants were given the TSST introduction (following a 10-min break and 5-min preparation) | 20 | 2 |
| Acute stress phase (including translation task and arithmetic task) | In the middle of the 10-min translation and 5-min arithmetic tasks | 45 | 4.5 |
| Completion of the tasks | After participants were debriefed | 55 | 5.5 |
| Recovery 1 | 15 min after the task was finished | 65 | 6.5 |
| Recovery 2 | 30 min after the task was finished | 80 | 8 |
| Recovery 3 | 45 min after the task was finished | 95 | 9.5 |

Note. Each saliva sample was collected 15 min after the cortisol level it was meant to measure, because it takes cortisol approximately 15 min to enter an individual’s saliva. TSST = Trier Social Stress Test.

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 a detailed description). Intraassay coefficients of variation (CVs) were between 4.0% and 6.7%, and interassay 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, & Zhang, 2017). 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, & Zhang, 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, & Zhang, 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 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 of English and Spanish on a scale from 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 hr 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 an 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 to examine cortisol response across seven time points and the moderating effect of 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 nonlinear; thus, the within-subject level modeled each participant's cortisol reactivity and recovery as a function of time (coding of time variables: .5 represents 5 min) 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-subjects level estimated the random effects for the within-subject 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:

¹ We 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 (Muthén & Muthén, 1998–2012), 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 (a) baseline cortisol, (b) cortisol response mean (mean of cortisol levels at the anticipatory phase, acute stress phase, and after completion of the tasks, controlling for baseline cortisol), and (c) 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 ($\beta = -.426, p = .007$), whereas language-brokering maternal dependence was positively associated with baseline cortisol ($\beta = .515, p = .002$). The overall R² for Model 1 was 19.4% ($p = .064$). For Model 2 (cortisol response as outcome), daily discrimination ($\beta = -.321, p = .015$) and language-brokering parental dependence ($\beta = -.223, p = .024$) were negatively associated with the response mean, controlling for baseline cortisol. The positive association between language-brokering efficacy for mother and cortisol response mean was marginal ($\beta = .234, p = .052$). 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 ($\beta = .164, p = .015$), 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.

$$\beta_{0i} = \gamma_{00} + \gamma_{01}Discrimination_i + \gamma_{02}Hostility_i + \gamma_{03}Efficacy_i + \gamma_{04}Dependence_i (+ \gamma_{05,6,7...Covariates_i) + u_{1i},$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}Discrimination_i + \gamma_{12}Hostility_i + \gamma_{13}Efficacy_i + \gamma_{14}Dependence_i + u_{1i},$$

and

$$\beta_{2i} = \gamma_{20} + \gamma_{21}Discrimination_i + \gamma_{22}Hostility_i + \gamma_{23}Efficacy_i + \gamma_{24}Dependence_i + u_{1i}.$$

Because 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-subject model (see 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 that the quadratic change in cortisol levels interacted with maternal hostility, sense of efficacy, and parental dependence (see Table 3, Model 2).

Table 2
Valid Cases, Means, and Standard Deviations for Study Variables

| Measure | Discrimination | Maternal hostility | Language brokering | | Raw cortisol | | | | | | | |
|-----------|----------------|--------------------|--------------------|---------------------|--------------|-------|-------|-------|-------|------|------|------|
| | | | Efficacy | Parental dependence | B | A | T | C | R1 | R2 | R3 | |
| <i>N</i> | | | | | | | | | | | | |
| Valid | 46 | 46 | 46 | 46 | 46 | 46 | 44 | 44 | 44 | 44 | 44 | 43 |
| Missing | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 3 |
| <i>M</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 |
| <i>SD</i> | .512 | 1.094 | .597 | .726 | 1.558 | 1.605 | 1.790 | 1.488 | 1.325 | .965 | .965 | .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
Multilevel Models Assessing Salivary Cortisol Levels During an Acute Stressor

| Predictor | Model 1: Within-Subject Model | | | | | Model 2: Random-Effect Model | | | | |
|---|-------------------------------|------|----|-------|-------|------------------------------|------|----|-------|-------|
| | β | SE | df | t | p | β | SE | df | t | p |
| Intercept | .333 | .142 | 45 | 2.34 | .024 | .334 | .135 | 41 | 2.47 | .018 |
| Time | .121 | .036 | 45 | 3.35 | .002 | .119 | .03 | 45 | 3.94 | <.001 |
| Time ² | -.018 | .003 | 45 | -6.44 | <.001 | -.018 | .002 | 45 | -7.72 | <.001 |
| Daily Discrimination | | | | | | .152 | .29 | 45 | .52 | .603 |
| Maternal Hostility | | | | | | -.004 | .135 | 45 | -.03 | .974 |
| Efficacy | | | | | | -.668 | .285 | 45 | -2.35 | .023 |
| Parental Dependence | | | | | | .664 | .249 | 45 | 2.66 | .011 |
| Daily Discrimination \times Time | | | | | | -.143 | .064 | 45 | -2.22 | .032 |
| Maternal Hostility \times Time | | | | | | -.033 | .03 | 45 | -1.09 | .283 |
| Efficacy \times Time | | | | | | .187 | .063 | 45 | 2.96 | .005 |
| Parental Dependence \times Time | | | | | | -.184 | .055 | 45 | -3.33 | .002 |
| Daily Discrimination \times Time ² | | | | | | .008 | .005 | 45 | 1.63 | .110 |
| Maternal Hostility \times Time ² | | | | | | .005 | .002 | 45 | 2.04 | .048 |
| Efficacy \times Time ² | | | | | | -.014 | .005 | 45 | -2.95 | .005 |
| Parental Dependence \times Time ² | | | | | | .013 | .004 | 45 | 2.98 | .005 |

Note. Discrimination, maternal hostility, efficacy, and parental dependence are grand-mean-centered. β represents unstandardized coefficients.

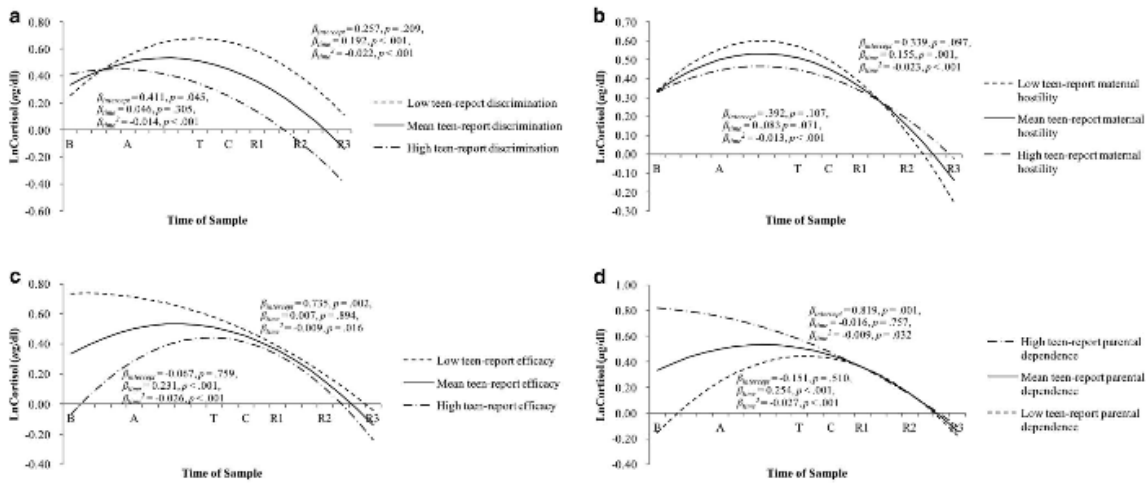


Figure 1. Model 1: Log-transformed cortisol level at each time point moderated by youth-reported global assessment of perceived discrimination (Panel a), maternal hostility (Panel b), and their sense of efficacy (Panel c) and parental dependence (Panel d) when language brokering for mother at high (+1 SD), mean, and low (-1 SD) levels. The x-axis refers to the time point of each event (e.g., base, anticipation), which occurred 15 min before the corresponding salivary cortisol samples were collected across the procedure. 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.

Simple slope analysis (see 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 (+1 SD: $\beta_{\text{intercept}} = .410, p = .045, \beta_{\text{time}} = .046, p = .305, \beta^2_{\text{time}} = -.014, p < .001$; -1 SD: $\beta_{\text{intercept}} = .257, p = .209, \beta_{\text{time}} = .192, p < .001, \beta^2_{\text{time}} = -.022, p < .001$; see Figure 1a). Relative to adolescents with higher scores on perceived maternal hostility, those with lower perceived maternal hostility scores exhibited faster recovery from the acute stressor (+1 SD: $\beta_{\text{intercept}} = .392, p = .107, \beta_{\text{time}} = .083, p = .071, \beta^2_{\text{time}} = -.013, p < .001$; -1 SD: $\beta_{\text{intercept}} = .339, p = .097, \beta_{\text{time}} = .155, p = .001, \beta^2_{\text{time}} = -.023, p < .001$; see 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 (+1 SD: $\beta_{\text{intercept}} = -.067, p = .759, \beta_{\text{time}} = .231, p < .001, \beta^2_{\text{time}} = -.026, p < .001$; -1 SD: $\beta_{\text{intercept}} = .735, p = .002, \beta_{\text{time}} = .007, p = .894, \beta^2_{\text{time}} = -.009, p = .016$; see 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 (+1 SD: $\beta_{\text{intercept}} = .819, p = .001, \beta_{\text{time}} = -.016, p = .757, \beta^2_{\text{time}} = -.009, p = .032$; -1 SD: $\beta_{\text{intercept}} = -.151, p = .510, \beta_{\text{time}} = .254, p < .001, \beta^2_{\text{time}} = -.027, p < .001$; see 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 or 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, as well as 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 results of 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 have seemed as stressful to them as are 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 participants' 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 of 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 overly 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). In a related vein, 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, because 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 there will be a clearer understanding of both the benefits and the risks of the language-brokering experience.

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