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Stress and Executive Control: Mediation and Moderation

DISSERTATION

submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in Education

by

Nancy Tsai

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Distinguished Professor Jacquelynne S. Eccles, Co-chair
Professor Richard Robins

2018
DEDICATION

To

all those who have taught me along the way.
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I would also like to acknowledge all my lab mates, peers, and dedicated research assistants who have made the journey a less lonely process.
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ABSTRACT OF THE DISSERTATION

Stress and Executive Control: Mediation and Moderation

By

Nancy Tsai

Doctor of Philosophy in Education

University of California, Irvine, 2018

Associate Professor Susanne M. Jaeggi, Chair

Distinguished Professor Jacquelynne S. Eccles, Co-Chair

Executive control functions (ECF) have captivated the scientific community for their role in predicting academic, professional, and health outcomes. ECF are also susceptible to the effects of stress and dominant theories point to the toxicity of stress, though there are notable inconsistencies. Inconsistencies in the literature might be because research has largely ignored the potential role of individual perceptions: The degree to which a stressor affects ECF may be related to the perception of a stressor as distressing and an individual’s beliefs. Three studies investigated these underlying mechanisms that may account for differences in the effects of stress on ECF.

In Study 1, I investigated the relationship between fictitious performance feedback (either positive or negative) and WM function in young adults while assessing a range of affect and self-belief constructs that might affect WM performance. Multiple regressions demonstrated that positive feedback resulted in better WM performance compared to negative feedback. Furthermore, for participants reactive to feedback, recent experiences of stress negatively impacted their performance regardless of feedback type.
These findings intimated the relationship between stress and WM but could not address whether this relationship might be explained by perceptions of distress.

In Study 2, I examined chronic stress on later inhibitory control in adolescents from a predominantly low-income background. Linear regression failed to detect a relationship between chronic stress and cognitive function. However, the relationship between chronic stress and perceived distress was statistically significant.

To examine the relationship between chronic stress and perceived distress, the role of individual moderators were included in Study 3. Self-esteem and optimism were found to moderate this relationship: High self-esteem and low optimism attenuated the negative effects of chronic stress on perceived distress, whereas low self-esteem acerbated these effects. Though findings from Study 2 failed to detect a relationship between ECF and chronic stress, the relationship between chronic stress and perceived distress was highlighted, then further explored in Study 3.

Collectively, the data obtained from these three complementary strands of work examine how stress impacts ECF, whether perceived distress accounts for this relationship, and to what extent individual beliefs moderate aspects of this relationship.
CHAPTER 1

Introduction
In 1936, when Hans Selye investigated a new hormone with mice stored in cages on the frigid rooftops above his laboratory in Montreal, he began to notice they all suffered a range of symptoms: enlarged adrenal glands, lymph node and thymic atrophy, and gastric ulcers (Selye, 1936). These findings ultimately led to his discovery of glucocorticoids, the biochemical cornerstone of what we now understand to be stress. Stress plays a major role in the etiology of mental and physical disorders and was first studied through anecdotal accounts of those who died following a major traumatic event, often from acute cardiovascular disorders (Taylor, 2010). Now, nearly a century after Selye’s first observations, research has linked stress to poorer mental and physical health outcomes such as heart disease (Bunker et al., 2003; Kivimaki et al., 2006), cancer (Ellison et al., 2001; Forsen, 1991), and generally shortened life spans (Bethune, 2007).

When scientists began examining the underlying mechanisms linking stress to health disparities, findings revealed changes in cognitive and immune function (Boyce et al., 1995; Bunker et al., 2003), which aligned with earlier work in the 1940’s that attempted to link personality types to illnesses (Holmes & Rahe, 1967).

The urgency to better understand is as great as ever--Hans Selye argued that stress is “medically, sociologically, and philosophically the most meaningful subject for humanity” (Selye, 1936). The field has come a long way since Selye’s rooftop discovery but evaluation is needed to understand the underlying mechanisms of stress reactivity that lead to individual differences in the unfolding pathways from stress to cognition and health. Our current examination of stress relies on interdisciplinary approaches--neurological, biophysiological, and psychological--in an effort to identify such mechanisms. We will discuss 1) the effects of acute stress on cognition and 2) factors that
moderate this relationship in an effort to shed more light on the varied cognitive and health outcomes.

**Stress and Cognition**

The influence of stress and arousal on cognition is well established (Al’Absi, Hugdahl, & Lovallo, 2002; Hoffman & Al’Absi, 2004; Sandi, 2013). Stress reactivity impacts higher order cognitive functions and in particular, executive control functions (ECF), which are generally regarded as important for cognitive outcomes as well as for quality of life more generally (Blair, Granger, & Razza, 2005; Blair et al., 2011; Diamond, 2013; Obradovic, 2016; Obradovic, Stamperdahl, Bush, Adler, & Boyce, 2010; Ursache, Stifter, Blair, & Voegtline, 2013). ECF includes a range of critical cognitive functions such as working memory (WM), commonly viewed as a limited capacity system that integrates, computes, manipulates, and stores information in mind for brief periods of time (Baddeley, 2000; Engle, 2002; Miyake & Shah, 1999) and cognitive control, the ability to actively maintain representations of goals and the means to achieve them (Duncan, 2001; Miller & Cohen, 2001). ECF processes underlie learning and a range of physical and mental health outcomes (Berking & Wupperman, 2012; Berking, Wirtz, Svaldi, & Hofmann, 2014; Gross & Munoz, 1995; Alloway et al., 2005; Gathercole, Brown, & Pickering, 2003; Gathercole & Pickering, 2000; Gathercole, Pickering, Knight, & Stegmann, 2004). To the extent that learning and mental health processes depend on ECF, stress could impair these outcomes by disrupting ECF and related processes.

Indeed, the dominant narrative in the scientific literature is that acute stress negatively affects ECF, though a meta-analysis found the effect of stress is more
pronounced with WM than with other domains of ECF (Shields, Sazma, & Yonelinas, 2016). Experimental studies of WM, for example, illustrate that stress induced by threatening stimuli (Lavric, Rippon, & Gray, 2003; Gray, Braver, & Raichle, 2002), fearful face stimuli (Kensinger & Corkin, 2003), and in the form of shame and guilt impair WM performance in a variety of tasks (Cavalera & Pepe, 2014). With the use of stress-sensitive physiological markers (e.g. cortisol), psychosocial stress induced with the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993) impair WM as assessed by the n-back task (Schoofs, Preub, & Wolf, 2008), forward and backward digit span task (Elzinga & Roelofs, 2005), and the reading span task (Luethi, Meier, & Sandi, 2009). The severity of cortisol reactivity following the TSST was proportional to the severity of subsequent WM impairment (Al’Absi, Hugdahl, & Lovallo, 2002). Similarly, when stress is induced by physiological means, e.g., by hand or foot immersion in ice water (the cold-pressor task) impaired performance on a range of WM tasks has been observed (Schoofs, Wolf, & Smeets, 2009; Duncko, Johnson, Merikangas, & Grillon, 2009). A meta-analysis examining the effect of acute stress on cognitive control more broadly, on the other hand, yielded overall no main effects (Shield, Sazma, & Yonelias, 2016).

Similarly, ECF appears to be sensitive to the effects of chronic stress. Some speculate that the cumulative and prolonged experience of stress during childhood, a sensitive period of brain development, can compromise the development of specific neural regions that underlie ECF function (Shonkoff & Phillips, 2000; Lupien, McEwen, Gunnar, & Heim, 2009). Chronic stress experienced during early childhood as young as seven months of age (Lupien, King, Meaney, & McEwen, 2000; Lupien, McEwen,
Gunnar, & Heim, 2009) are uniquely associated with ECF and academic achievement in pre-kindergarten (Blair, Granger, & Razza, 2005; Blair et al., 2011; Berry, Blair, & Willoughby, & Granger, 2012). Higher levels of cortisol, a biophysiological measure of stress, assessed longitudinally during early childhood, were associated with lower ECF (Blair et al., 2011; Ursache et al., 2013; Gunnar, Frenn, Wewerka, & Van Ryzin, 2009). The underlying causal mechanisms operating between chronic stress and ECF are less clear, in part because the extended nature of chronic stress may be obscured by a myriad of other developmental influences, and also because experimental work has focused on acute stress as a result of the challenges and ethical concerns involved in experimentally manipulating chronic stress in human research participants. As such, the following discussion of mechanisms will center on acute stress although when relevant, results from studies of chronic stress will be highlighted. For purposes of brevity, acute stress will be referred to as “stress” hereafter unless otherwise specified.

The impact of stress on ECF can be described as a limitation of resources and as such, the Professing Efficiency Theory (Eysenck & Calvo, 1992) and Attentional Control Theory (Eysenck, Derakhshan, Santos, & Calvo, 2007) were put forth to explain the reallocation of cognitive resources when processes such as inhibition, stress, and negative thoughts co-occur. In other words, stress interferes with the inhibition, shifting, and other processes of ECF by consuming cognitive resources that would otherwise be available to such functions (Berggren & Derakshan, 2013). Neurobiological work supports this resource allocation theory as both stress and ECF are maintained by closely related neural systems. The prefrontal cortex (PFC) is particularly vulnerable to the deleterious effects of stress suggesting that ECF and related cognitive functions supported by this neural
region might be equally affected by stress (e.g., Herman, Ostrander, Mueller, & Figueiredo, 2005). Studies in rodents and non-human primates show similar relationships with stress-induced impairments of ECF followed dopaminergic and adrenergic processes in the PFC (e.g., Arnsten & Li, 2005; Murphy, Arnsten, Jentsch, & Roth, 1996), suggesting that stress-induced chemical imbalances in the PFC mediate cognitive impairments. When psychological stress is induced by TSST, increased glucocorticoid levels were coupled with impaired WM performance (see Elzinga & Roelofs, 2005; Lupien et al., 1999; Schoofs et al., 2008 for examples). Furthermore, functional MRI findings demonstrate that acute stress as induced by viewing strongly aversive movie material showed impaired WM performance and reduced dorso-lateral PFC activity (Qin, Hermans, van Marle, Luo, & Fernandez, 2009) or preserved performance and increased dorso-lateral PFC activity (Kohn, Hermans, & Fernandez, 2017). Complementary imaging results were found for cognitive control under psychosocial stress impairment and reduced dorso-lateral PFC activity (Liston, McEwen, & Casey, 2009). When stress was induced by stereotype threat, women under threat showed decreased BOLD activity of the prefrontal cortex during the math task and instead showed heightened activation in neural regions associated with social and emotional processing, which resembles the behavioral results that their performance was impaired under stereotype threat (Krendl et al., 2008). Together, these findings from animal and human literature underscore the harmful effects of stress on ECF and other prefrontal related functions.

However, the evidence of a negative impact of stress on ECF is not consistent across all studies, even within specific domains of ECF. In some studies of WM, for example, only very high levels of stress impaired function (e.g., Oei et al., 2006).
Furthermore, stress as induced by hydrocortisone injection (Kuhlmann, Kirschbaum, & Wolf, 2005) or cold-water hand-immersion (Porcelli, Cruz, Wenberg, & Patterson, 2008) does not always lead to impairments in WM (Wolf et al., 2001) or inhibitory control (Schwabe, Hoffken, Tegenthoff, & Wolf, 2013). Not only do the varied findings indicate that specific sub-processes of ECF might be differentially susceptible to the effects of stress (Schoofs et al., 2008; Hoffman & Al’Absi, 2004; Kuhlmann, Piel, & Wolf, 2005; Smeets, Jelicic, & Merckelbach, 2006) but also that ECF might only be impaired with greater exposure to stress. More definitively, however, is that the varied findings on the effects of stress across and within ECF highlight individual differences in the experience of stress and ECF.

**Mechanism**

Consider for a moment an impending high-stakes examination that determines college placement—certainly not everyone faced with this daunting examination would respond in an identical manner but instead, we might expect a range from excitement to crippling anxiety depending on the individual. Could perception of the exam account for these individual differences in response to this “stressor” and more broadly, elucidate the inconsistent findings surrounding the acute stress literature? According to literature, the perception and evaluation of potential harm posed by the stressor is fundamental to the effect of *psychological* stress; Occurrences exert their influence only if the recipient *perceives* them as stressful. Psychological stress is determined by the person’s interpretations of the situation and not only by objective assessment of experiences. This is precisely why someone facing their fear of public speaking may elicit the same set of biophysiological responses as if approached by a hungry lion. In fact, Ali and colleagues
(2017) found that following an acute psychosocial stressor, participants still experienced emotional stress even when autonomic and endocrine stress responses were suppressed, demonstrating dissociation between the two systems and the importance of subjective emotional experiences. In 1971, Mason argued that stress is primarily a measure of the participant’s reactivity—if a participant does not perceive the input as distressing or negative, the physiological response patterns will not manifest. Thus, the idea of distress is rooted in the redefinition of stress: a “negative psychological response to such threats can include a variety of affective and cognitive states, such as anxiety, sadness, frustration, the sense of being overwhelmed, or helplessness” (Kemeny, 2003). According to these psychological theories of stress, distress needs to be perceived as disparate cognitive appraisals can lead to different physiological responses.

A heuristic model by Lazarus and Folkman (1984) unifies these ideas. The model identifies two processes involved in cognitive appraisal as key mediators of stressful encounters and the immediate and long-term outcomes. Cognitive appraisal includes two appraisals: primary appraisal (Is the stimulus threatening or benign? Is the stressor important to my well-being? Is this stressor of importance to my life?) and secondary appraisal (Do I have the resources to cope with the situation?) (Figure 1.1). Primary appraisal is the perception of the weight of the situation whereas secondary appraisal assesses perceptions of personal and situational resources. The crux of the model lies in the convergence of primary and secondary appraisal to determine whether the stressor-person interaction is significant for the well-being and if so, whether the demands and adaptive capacities are sufficient in meeting the needs of overcoming the stressor — whether the stimuli is perceived as stressful or benign would then lead to a chain of
physiological or behavioral responses. Therefore, the more personally relevant the stressor, the more likely the participant will experience anxiety to perform at a high level (Baumeister, 1984). Depending on such appraisals, a stressor is then perceived as a threat (“distress”) or a challenge (“eustress”). The distinct perceptions—challenge versus threat—are accompanied by distinctive psychological and physiological responses: challenge is accompanied by feelings of competence and positive affective paired with improved cardiac efficiency and dilation of the peripheral vasculature suggesting greater utilization of energy resources. Threat, however, is accompanied by feelings of withdrawal and defeat paired with decreased cardiac efficiency and vasculature constriction (Jamieson, Mendes, & Nock, 2013).

Though the current theoretical appraisal model predicts outcomes, it fails to explain the varied outcomes found in literature. The appraisal of challenge or threat ought to account for the psychological context in which appraisals are made, including the influence of factors that result from individual differences. Individual variables such as gender are frequently examined for their moderating role whereas psychological factors, those likely involved in the assessment of internal resources, have yet to be regularly considered. A review of potentially relevant psychological factors as related to the secondary appraisal of resources (Figure 1.1) will form the remainder of our discussion.

**Moderators**

Cognitive appraisal is an assessment of the interaction between environment and individual given a specific transaction. This interaction is a function of a specific set of environmental conditions that are appraised by the individual with particular psychological characteristics. Threat is not a fixed property of the situation; it is a result
of appraisal that assesses the relative match between perceived coping abilities and
challenges of the situation. Appraisal inherently depends on individual factors (Figure
1.1). Thus, just as the objective challenges posed by the situation are important,
personality, culture, and other contextually meaningful influences are central to
perception. ECF is variable even within the individual with various factors causing
differences in ECF, and similarly, affective states and attribution are also state dependent.

Returning to formative theories that present stress as a cognitively taxing affective
process, we would surmise that positive affect, to the contrary, might be cognitively
relieving. Well over three decades ago, Lazarus, Kanner, and Folkman (1980) considered
the functional role that positive emotions serve in the face of stress and hypothesized that
under stressful conditions, positive emotions may temporarily relieve the cognitive
weight caused by the negative experiences of stress. Fredrickson (2001) later proposed a
complementary broaden-and-build theory, explaining that positive and negative emotions
have distinct cognitive effects: Negative emotions are said to narrow attention and
cognitive function associated with negative emotions to prepare for a specific adaptive
function (e.g., attack when angry) whereas positive emotions broaden the individual’s
attentional focus, expanding the range of cognitions and behaviors that come to mind.
This broadening of attentional focus, Fredrickson argues, affords the individual physical,
intellectual, and social resources directly influencing secondary appraisal (Do I have the
resources to cope with the situation?). Indeed, using fMRI, Schmitz et al. (2009) was able
to show that positive mood was associated with increased neural activity and regional
connectivity during a selective attention task. Storbeck and Maswood (2016) found that
positive mood induction enhanced verbal and spatial WM capacity as assessed by the O-
span task. Impacts on creative thinking (see Ashby, Isen, & Turken, 1999), cognitive flexibility (Isen, Rosenzweig, & Young, 1991), task-switching, (e.g. Isen & Shmidt, 2007), inhibitory control (e.g. Gray, 2001), among others (see Isen, 2008, for a review) support the notion that positive affect improves ECF related functions. However, positive affect has also demonstrated differential negative impacts on cognitive control functions, impairing WM (as assessed with Running Memory Span) but not response inhibition (assessed with the Stroop Task) (Martin & Kerns, 2011) and increasing distractibility (Dreisbach & Goschke, 2004).

Positive affect in relation to expected outcomes might also be related to stress outcomes. Self-efficacy is defined as an individual’s confidence in their ability to mobilize the motivation, cognitive resources, and action needed to meet a given demand (Bandura, 1986). Bandura characterized self-efficacy as a multi-dimensional construct that varies in strength, generality, and difficulty and focuses on expectancies for success. Thus, an individual’s beliefs about whether they can effectively perform to meet a desired outcome might influence how much stress they experience when they are met with adverse situations. In two separate studies, coping self-efficacy mediated the acute stress responses and long-term distress following either childhood sexual abuse (Cieslak, Benight, & Lehman, 2008) or a natural disaster (Benight & Harper, 2002). It might be that those with low self-efficacy tend to appraise stressors as more threatening and less manageable, prompting higher stress responses. Those who are confident in their abilities to manage the stressor are not impacted to the same extent as those who are not confident. The critical process therefore is secondary appraisal and whether an individual evaluates their abilities and motivation as sufficient in coping with the stressor at hand.
Thus, with greater confidence in one’s abilities and motivation, a particular situation is met with increased perceived resources to manage a stressor. In a study of immigrant and minority college freshman, Zajacova, Lynch, and Espenshade (2005) found that compared to self-reported task-specific stress, self-reported academic self-efficacy was a stronger predictor of academic success as measured by first year college GPA, number of accumulated credits, and college retention after the first year further suggesting the protective nature of self-efficacy. In an examination of performance of mathematical problem solving, Hoffman and Schraw (2009) found that the combination of high self-reported task-specific self-efficacy and high WM capacity measured by behavioral performance on an ordered letters task was related to improved problem solving. Self-efficacy accounted for a significant proportion of the variance in performance accuracy, more so than WM capacity, indicating its strength in predicting performance above all other variables. Thus, the belief about whether one can effectively perform to meet certain obstacles can promote a challenge approach during stress appraisal.

Another contribution to an individual’s beliefs about their expectancy for success is the concept of locus of control: the extent to which one feels in control of one’s successes and failures (Rotter, 1966). Related to self-efficacy, those who believe they control their achievement outcomes should feel more competent and have higher self-efficacy. Secondary appraisal questions whether one has the adequate resources needed to cope with a situation, thus the perception of control might correlate with stress reactivity in relation to the perception of threat or challenge (Figure 1.1). Returning to Frankenhaeuser’s (1979) model of HPA and SNS responses, the perception of control is the key in determining where on the spectrum of helplessness (distress without effort) or
mastery (effort without distress) one lies and the resulting paired interaction of cortisol and epinephrine. A meta-analysis review of over 208 studies found the effect size for tasks with a component of uncontrollability was over three times greater than other controllable stress tasks (0.52 vs. 0.16), indicating that humans are more likely to experience HPA activation if they think the stressor is uncontrollable rather than controllable (Dickerson & Kemeny, 2004). However, the findings of the meta-analysis do not account for the differences between types of stressors that have qualifying elements of uncontrollability (e.g. are they evaluative or not?) but in a study of young and elderly subjects, cortisol response to the psychological stress task was significantly correlated with locus of control (Pruessner et al., 2005). It has been argued that locus of control as a trait like characteristic acts as a mediator between life stressors and impairment of mental and physical well-being (Denney & Frisch, 1981; Husaini & Neff, 1981; Johnson & Sarason, 1978; Lefcourt, Miller, Ware, & Sherk, 1981; Kobasa, Maddi, & Kahn, 1982). Studies of individuals exposed to mental challenge tasks (Pruessner, Hellhammer, & Kirschbaum, 1999) or medical stressors such as spinal cord injuries (Bulman & Wortman, 1977) and haemodialysis treatment (Poll & Kaplan De-Nour, 1980) indicate that self-reported internal locus of control was correlated with less self-reported distress, lower cortisol responses, and also better outcomes. Taken together, these findings affirm the importance of perceived control over outcomes and whether one believes they can do a task can lead to differences in stress reactivity.

**Goals and Aims**

Studies of stress and cognition have focused primarily on the neurobiological and physiological mechanisms or, on rare occasion, their interaction. Moreover, the
psychological state of the individual as an additional ‘system’-- one that arguably drives changes in the physical systems--is not commonly accounted for, at least not in conjunction with others. This failure to consider the psychological state is a surprising omission in current work given the embodiment of the mind and the inarguable existence of subjective stress. Understanding the mediators and moderators of the stress appraisal process and whether or not this theoretical model holds longitudinally could better account for individual differences in both acute and chronic stress responses. Identifying such underlying mechanisms can ultimately inform the development of socially meaningful mental and physical-health interventions.

The studies included in my dissertation are aimed to examine the underlying mechanisms that promote differences in the effects of acute and chronic stress on ECF. I examine these relationships in adolescence and young adulthood using experimental and longitudinal methods.

Overview of the Chapters

Chapter 2: Fictitious Feedback and Working Memory

The first study used fictitious feedback (positive or negative) to induce affective changes in students engaged in a WM task. I then assess the extent to which the feedback affects students’ WM performance while administering questionnaires to assess their perceptions of stress, anxiety, self-concept of ability, and other individual beliefs. This study allows me to examine the effect of an educationally relevant, ecologically valid stressor on ECF while also exploring the influence of self-beliefs and affective states on this relationship.
Chapter 3: Chronic Stress and later Adolescent Inhibitory Control:

Perceived Distress as Mediator

For the second study, the influence of chronic environmental stress on inhibitory control was examined. Using a pre-existing longitudinal dataset, adolescents from a predominantly low-income high school self-report exposure to a range of chronic stressors (at approximately age 14) and later perform an inhibitory control task (at approximately age 19). Perceptions of distress and anxiety as self-reported (at approximately age 16) are examined as a mediator of this relationship. I created a cumulative score for chronic stress exposure from four separate measures of stress (e.g., neighborhood crime exposure) and used a mediation regression analysis to investigate the direct and indirect effects of environmental stress and distress on inhibitory control. Parental combined education, income-to-needs ratio, and a questionnaire for depression were included as covariates. This study allows me to examine the long-term effects of chronic stress on inhibitory control and the potential mediation of perceptions of distress.

Chapter 4: Chronic Stress and Distress: Self-Esteem and Optimism as Moderators

As an extension to Chapter 3, individual belief variables were included to test for moderated-mediation. Specifically, variables such as self-esteem and dispositional optimism were examined to test whether they moderated the relationship between environmental stress and perceptions of distress. Building off the regression analysis of the second study, the inclusion of the two moderators allows me to examine the independent contributions of self-esteem and dispositional optimism on perceptions of distress.
Collectively, the data obtained from these three complementary strands of work reframes theories about how stress impacts ECF and widens the discussion on how individual psychological beliefs moderate this relationship.

Figure 1.1. A theoretical model of stress (Lazarus & Folkman, 1984) with the modification of beliefs such as self-esteem considered as potential moderators.
References


reduced pro-inflammatory cytokine reactivity to emotional stress. *Stress, 19*(1), 63-68.


CHAPTER 2

Fictitious Feedback and Working Memory
Abstract

The use of feedback aimed to improve performance is ubiquitous, particularly in educational contexts. Feedback is given to improve learning but the empirical work examining its efficacy is rife with contradictions. Because feedback can be perceived as a stressor due its social-evaluative nature, the current study examines the effect of fictitious feedback as a potential stressor on working memory (WM) performance, a core ECF that facilitates learning outcomes. To identify individual characteristics that may account for differential outcomes, measures such as perceived stress were included. We find that those receiving positive feedback outperformed those receiving negative feedback suggesting that the administration of positive feedback, as opposed to negative feedback, may be more conducive to optimizing critical cognitive functions in learning environments. Although participants were not uniformly emotionally reactive to feedback, for those who were emotionally reactive to the feedback, higher perceived experiences of recent stress negatively impacted WM performance following feedback, irrespective of feedback type.

Keywords: social-evaluation, cognitive function, stress, locus of control
Introduction

Feedback is one of the most powerful tools for improving performance, but it is highly variable in its influence on performance outcomes and can result in impaired rather than enhanced performance (Hattie & Temperley, 2007; Kluger & DeNisi, 1996; Shute, 2008). In a review of 12 separate meta-analyses examining the efficacy of feedback in the classroom, the implementation of varying types of feedback – ranging from student ratings to teacher praise – Hattie & Timperley (2007) reported an average effect size of 0.79 for each meta-analysis, twice the average effect (Hattie, 2009), highlighting the critical role of feedback in student achievement. However, another meta-analysis found the effect of feedback to be so variable that while it did improve performance on average, it reduced performance in nearly a third of the cases (Kluger & DeNisi, 1996). These sizable yet variable effects could be due to the fact that feedback, particularly negative feedback, could either act as a social-evaluative stressor (Cody & Teachman, 2010) but it could also be motivating in other cases (Tolli & Schmidt, 2008), and as such, reflect the influence of other factors not yet considered.

How the feedback recipient receives feedback and how this information is processed cognitively ought to be considered. Individual differences in response to feedback might reflect the role of executive control in processing such information in the service of a goal. Working memory (WM), a critical executive control function that integrates, computes, and stores information in our mind for brief periods of time (Baddeley, 2000; Miyake et al., 2000) is fundamental to learning and as such, is highly predictive of academic outcomes (Alloway et al., 2005; Gathercole, Brown, & Pickering, 2003; Gathercole & Pickering, 2000; Gathercole, Pickering, Knight, & Stegmann, 2004).
Interestingly, WM is unique in that it both regulates and reacts to stress (Elzinga & Roelofs, 2005; Luethi, Meier, & Sandi, 2009; Schoofs, Preub, & Wolf, 2008). Evidence demonstrating that stress negatively impacts WM includes negatively charged affective stimuli (e.g. Kensinger & Corkin, 2003) to inducing shame and guilt (Cavalera & Pepe, 2014) or psychosocial stress (e.g. Schoofs, Preub, & Wolf, 2008). Furthermore, persistent experiences of stress as indicated by life stress are linked to impaired WM function. For example, Klein & Boals (2001) theorize that people under persistent stress tax their mental resources in the attempt to suppress unwanted negative thoughts and feelings, resulting in weakened cognitive function. Given WM’s regulation of and reactivity to stress along with its predictive role in long-term academic outcomes, maintaining optimal WM is especially relevant in tough learning environments (see Duncan et al., 2007; Pagani, Fitzpatrick, Archambault, & Janosz, 2010 for meta-analysis). However, the impact of commonly used instructional practices such as feedback administration on WM performance itself is unknown, despite having features such as uncontrollability of performance outcome and social evaluation that reliably induce stress and cortisol responses (Dickerson & Kemeny, 2004).

The current body of literature has only highlighted the variable effects of feedback; it does not differentiate between feedback type, how feedback impacts WM, nor whether perceptions of stress moderates the effects of feedback. The current study aimed to address these issues. Specifically, our research questions are 1) to what extent does negative or positive feedback affect WM performance? And 2) do individual differences in perceived stress account for change in WM performance upon receiving positive or negative feedback?
Based on the findings of Dickerson & Kemeny (2004), we hypothesize that negative feedback as compared to positive feedback would result in poorer performance on the WM task following feedback. Furthermore, we predict that this relationship is partially mediated by participants’ perceptions of distress—altered perceptions of stress following feedback would show altered performance on the WM task. Because behavioral results from studies on positive feedback and performance are mixed, we had no specific hypotheses regarding the effects of positive feedback but generally expect this group to outperform the group that was given negative feedback.

Methods

Participants

Ninety-seven undergraduate students from UC Irvine participated in the study and provided consent in accordance with the guidelines set by the IRB of UCI. Five participants were excluded from the study for any or a combination of the following reasons: failure to complete the task (n=1), experienced major interruptions during the task (n=1), misinterpreted the feedback (n=1), felt feedback was unclear (n=2), or did not believe the feedback (n=3). Ninety-two participants were included in the final analysis (83% female; age M= 22.71, SD=7.43). Prior to testing, participants were randomly assigned to one of 2 conditions, receiving either negative (n=47) or positive feedback (n=45) about their WM performance.

Procedure

Upon arriving, participants were given an overview of research conducted in the laboratory and told that this particular study was a “cross-cultural cognitive study” in
order to disguise the nature of the study (Figure 2.1). A narrated power point slide show was presented to the participant, emphasizing the importance of WM and its predictive value in academic and professional life with the intent of increasing engagement and self-relevancy. Participants were informed that the WM task would include feedback about their performance. Unbeknownst to participants, the feedback presented was fictitious, created prior to the experiment, and was presented irrespective of the participants’ actual performance. Participants were then given instructions on the WM task and asked to complete a few practice trials. The actual WM task began with four 1-minute blocks without feedback, followed by a self-paced questionnaire to monitor any potential changes in stress due to participation in the study. The participants were then told they would be performing the same task but this time, they would be presented with feedback on their performance relative to other participants using a combination of both accuracy as well as reaction time in an effort to make the fictitious feedback more credible. Participants completed ten blocks, with fictitious feedback (“You are performing X% below/above average.”) presented immediately following blocks 4, 6, 8, 10, and 12. Measures of negative affect (stress and anxiety) were collected 24 hours prior to the beginning of the study, after the first four rounds of the WM task without feedback, and after the last round of the WM task. The first questionnaire was administered 24 hours prior to the experiment via email to prevent participants from gaining insight into the intent of the study and in order to gather an unbiased baseline. After completion of the post-test questionnaire, participants were debriefed about the true nature of the study.
Figure 2.1. Procedure used for the study.
Measures

*Working Memory Task: 2-Back task (Jaeggi et al., 2010)*

The WM task was computerized (E-Prime, Psychology Software Tools, Pittsburgh, PA) and consisted of a sequential presentation of geometric shapes (Figure 2.2). Participants were asked to respond to each shape and indicate whether the shape that was currently presented on the screen was the same or different as the one presented 2-before (2-back task). Responses were given via key press. Participants completed 14 blocks in total (4 blocks without feedback and 10 blocks with feedback presented after every two blocks), and each block consisted of 15 trials with 5 targets and 10 non-targets. The stimuli were displayed for 500ms with an interstimulus interval of 2500 ms. The dependent variable for WM performance was the average accuracy, calculated from the proportion of correctly identified targets (hits) minus the proportion of false alarms (Snodgrass & Corwin, 1988). Accuracy across the first four blocks without feedback was averaged serving as a measure of WM performance at baseline, and the average accuracy for the last 10 blocks following feedback served as a measure of WM performance as a function of fictitious feedback. The change in WM performance comparing baseline and following feedback serves as our primary dependent variable of interest.
Figure 2.2. Stimuli used for the 2-back task included geometric shapes. Participants were instructed to press “R” if the currently presented shape matched with the shape presented two presentations before, and “L” otherwise.
Feedback

The feedback statements provided to both groups were identical except for the word above or below (e.g. “You are performing 47% [above/below] average”). The order in which the feedback statements (i.e. that percentages) were presented also remained constant between the two conditions (43%, 52%, 37%, 53%, 47%). Given the potential misinterpretation of such feedback, participants were asked if they understood or believed the feedback as part of the post-study questionnaire as a manipulation check. Participants who misinterpreted feedback and/or did not find the feedback believable were excluded from the analyses (n=3).

Self-Report Measures

The Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983) was administered to assess perceptions of stress experienced during the last month before the experiment (Appendix I). The abbreviated scale consists of four questions that evaluate how the participant has felt over the last month. A typical item is, “In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?” to which the participant selects from the following 5-point Likert scale (1-Never to 5-Very often). The dependent variable was the average value for the four questions with a higher score indicating higher levels of perceived stress. This perceived stress questionnaire was part of the pre- and post-questionnaire.

The State-Trait Anxiety Inventory (STAI) (Marteau & Bekker, 1992) was administered to gauge state stress and anxiety at that particular moment (Appendix II). The abbreviated scale consists of seven questions that evaluate how the participant presently feels. A typical item is, “How stressed do you feel right now?” to which the
participant selects from the following 5-point Likert scale (1-Not at all to 5-Extremely). The dependent variable was the average value for the seven questions. The STAI questions were part of the pre-, mid-, and post-questionnaires.

For exploratory purposes, we included four additional questions to assess self-concept of ability (SCA) (Appendix III). A typical item is, “How good are you at doing cognitive challenging tasks today (e.g. IQ tests),” to which the participant selects from the following 5-point Likert scale (1-poor to 5-excellent). The dependent variable was the average value for the four questions. The questions were part of the pre-, mid-, and post-questionnaires.

Analytical Approach

Data were first analyzed with independent t-tests to examine whether the two groups differed at baseline with regards to WM performance and perceived stress. The average accuracy on the first four rounds of the 2-back task served as our WM baseline measure since feedback had not yet been administered. Because our primary aim was to examine the effects of feedback on WM performance, the change in performance following feedback as compared to baseline was the dependent variable. Regression was used to examine the effect of feedback on WM performance, as well as the effect of perceived stress on this relationship. The model was set with the following independent determinants: baseline WM, Condition, and perceived stress. The alpha level used to determine statistical significance was 0.05. All participants indicated that their performance on the WM task was at least moderately important to them.
Results

Participant characteristics as a function of group

Overall, the two feedback groups did not differ at baseline, neither in WM performance \( (t(90)=1.85, p=.067, d=0.387, BF_{10}=0.98) \), STAI \( (t(90)=-1.01, p=.311, d=-0.21, BF_{10}=0.345) \), SCA \( (t(90)=1.00, p=0.319, d=0.209, BF_{10}=0.34) \), nor perceived stress \( (t(90)=0.71, p=.477, d=0.149, BF_{10}=0.27) \), and there were no significant group differences in age \( (t(33)=0.083, p=0.934, d=0.028, BF_{10}=0.32) \) or gender distribution \( (t(90)=0.188, p=0.851, d=0.039, BF_{10}=0.22) \) (Table 2.1).

Table 2.1
Summary Statistics and Group Comparisons for Key Measures by Feedback Condition

<table>
<thead>
<tr>
<th>Variables</th>
<th>Positive Feedback ( (n = 45) )</th>
<th>Negative Feedback ( (n = 47) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>22.82 (5.71)</td>
<td>22.61 (8.93)</td>
</tr>
<tr>
<td>Female</td>
<td>84%</td>
<td>83%</td>
</tr>
<tr>
<td>Baseline assessments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSS at baseline</td>
<td>2.90 (0.82)</td>
<td>2.77 (0.83)</td>
</tr>
<tr>
<td>SCA at baseline</td>
<td>3.1 (0.61)</td>
<td>2.96 (0.69)</td>
</tr>
<tr>
<td>STAI at baseline</td>
<td>2.44 (0.83)</td>
<td>2.61 (0.80)</td>
</tr>
<tr>
<td>STAI post-feedback</td>
<td>2.52 (0.72)</td>
<td>2.74 (0.71)</td>
</tr>
<tr>
<td>Post-feedback</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WM at baseline</td>
<td>0.45 (0.21)</td>
<td>0.38 (0.19)</td>
</tr>
<tr>
<td>WM post-feedback</td>
<td>0.61 (0.16)**</td>
<td>0.50 (0.19)**</td>
</tr>
</tbody>
</table>

Note. Means (SD). The Positive and Negative Feedback groups did not significantly differ in any measure except in average performance on the rounds following the administration of feedback. **\( p<0.01 \)

Effects of feedback on WM performance

We used regression analyses to examine the changes of WM performance following feedback. Within our sample, baseline WM performance \( (t(87)=-5.10, p=.000, \eta^2=.23, BF_{10}=5610.02) \) and Condition were significant \( (t(87)=-2.10, p=.038, \eta^2=.048, BF_{10}=1.77; \text{Figure 2.3}) \) while perceived stress \( (t(87)=-1.35, p=.182, \eta^2=.020, BF_{10}=0.58) \).
and SCA ($t(87)=0.55$, $p=.585$, $\eta^2=.004$, $BF_{10}=0.34$) were not. To examine the potential moderating effect of perceived stress and SCA on feedback response, the interaction of PSS x Condition ($t(86)=1.17$, $p=.244$, $\eta^2=.015$, $BF_{10}=0.53$) and SCA x Condition ($t(85)=-0.75$, $p=.45$, $\eta^2=.006$, $BF_{10}=0.67$) were included but were not significant.

**Figure 2.3.** Accuracy scores during pre-feedback rounds and post-feedback rounds, as a function of feedback condition. 1a: all participants ($n=92$). 1b: only reactive participants, i.e., participants who reported a change in STAI as a function of feedback ($n=42$). Error bars represent standard errors of the mean. For a more detailed picture illustrating potential reactivity over time, performance was graphed as a function of feedback over time (see Appendix IV).

Furthermore, given that there were numerical but non-significant differences in baseline WM performance between the two participant groups, propensity score matching was used to compare a matched subsample to confirm no significant differences at baseline ($F(3, 61)= 1.77$, $p=0.16$) (baseline as outcome variable) and replicate our findings above highlighting the predictive role of Condition ($t(63)=-3.34$, $p=.001$) and
baseline WM performance (t(63)=-4.83, p<.001) on change in WM performance following feedback.

*Manipulation Check*

At the end of the experiment, we asked participants whether the feedback was clear and whether they believed in the feedback, and we excluded those who guessed the hypothesis of the study, misinterpreted or did not believe the feedback (n=4). Furthermore, since fictitious feedback was intended as a manipulation of stress, we assessed the efficacy of the stress induction by evaluating whether participants reported different levels of distress and anxiety after exposure to fictitious feedback. However, when examining change in STAI from pre- to post-test (as a difference score), there were no differences between the two feedback groups (t(90)=-0.26, p=0.79, η²=-.054, BF₁₀=0.034).

*Individual differences on 2-Back performance post feedback*

Because our feedback manipulation was not effective in changing participants’ levels of distress and anxiety at least as evidenced by the overall lack of significant changes in STAI over the course of the experiment, the relationship between feedback, perceived stress, and WM performance, may be better captured by focusing on participants who actually did report reactivity to feedback. We operationalized reactivity as change in STAI as expected according to Condition: negative feedback should increase STAI whereas positive feedback should decrease in STAI given its intent as a measure of distress and anxiety. Reactivity was thus coded with 1 if participants experienced change in the expected direction, and with 0 otherwise. Our models were re-run focusing only on
these reactive participants (positive n=17; negative n=25). For this feedback-reactive sample, baseline WM (t(37)= -3.06, \( p=0.004 \), \( \eta^2=0.202 \), BF\(_{10}=9.50 \)) and Condition (t(37)= -2.33, \( p=0.025 \), \( \eta^2=0.128 \), BF\(_{10}=2.21 \)) were statistically significant while SCA was not (t(37)= 0.82, \( p=0.418 \), \( \eta^2=0.016 \), BF\(_{10}=0.50 \)), replicating the effects of the full sample. Furthermore, in this sample, perceived stress was now a significant predictor (t(37)= -2.19, \( p=0.035 \), \( \eta^2=0.115 \), BF\(_{10}=1.87 \)) indicating that higher feelings of stress related to poorer performance following feedback, irrespective of feedback type (Figure 2.3). To examine the potential moderating effect of perceived stress on feedback response, the interaction of PSS x Condition (t(37)= -0.17, \( p=0.868 \), \( \eta^2=0.000 \), BF\(_{10}=0.45 \)) and SCA x Condition (t(37)= 0.02, \( p=0.985 \), \( \eta^2=0.000 \), BF\(_{10}=0.58 \)) were included but both remained non-significant in this reactive subsample.

Discussion

By administering fictitious feedback, we found differential effects of feedback type on WM performance: participants who received positive feedback showed greater gains on the WM task compared to those receiving negative feedback, aligning with our initial hypothesis. We also hypothesized that participants with higher perceptions of stress would show smaller gains in performance compared to those with lower perceptions of stress on the WM task following feedback, which we were able to support with our secondary analyses with the reactive subsample. These findings emphasize the importance in affective states in cognitive outcomes, and more importantly, its relevance in educational contexts when certain practices aimed to improve learning outcomes can actually hinder optimal function.

By assessing perceptions of stress and anxiety prior to and following feedback,
we aimed to monitor potential changes in those perceptions in our participants but faced challenges similar to other studies aiming to induce ecologically valid albeit subtle stressors using positive and negative feedback as a proxy. Our data suggest that our feedback manipulation was too subtle to reliably change feelings of stress and anxiety in our participant sample, and/or that STAI was not sensitive enough as a measure to capture any subtle changes. The relationship between feedback, perceived stress, and WM performance may have been masked due to the diluted potency of the stressor. In addition to considering a more potent stressor, the inclusion of physiological measures might better capture stress-induced changes in WM and executive control that are associated with changes in physiological measures of stress (Plessow, Kiesel, & Kirschbaum, 2012; Schoofs et al., 2008). In the absence of physiological measures, we focused on a subset of participants who indicated reactivity to feedback by reporting changes in stress and anxiety following feedback. Focusing on this reactive subsample, the results remain consistent with the patterns seen in the full sample: Those receiving positive feedback out-gained and out-performed those receiving negative feedback. In fact, the effect of Condition was nearly three times as large for this reactive subsample ($\eta^2=0.128$) as compared to the full sample ($\eta^2=0.048$). Moreover, these secondary analyses also revealed that perceived experiences of recent stress (“in the last month”) were equally influential on WM following feedback such that higher perceived stress experienced recently were correlated with poorer WM performance following feedback, irrespective of whether the feedback was positive or negative. This finding underscores the reach of more chronic experiences of stress and its persistence on taxing mental resources and is not alleviated when one is administered positive feedback on a current
task. Because both chronic and acute experiences of stress appear to have potent effects on WM, as indicated by our findings, it would be valuable to evaluate what environmental or individual factors moderate these effects.

The primary aim of the current study was to examine the effects of feedback on cognitive function and highlight the vulnerability of WM with respect to stress. Importantly, WM is unique in that it both responds to and regulates stress. Prior work examining WM in a regulatory role has found that high WM ability leads to less variability (e.g., impairment) in performance under affective states (e.g., stress) (Schweizer, Grahn, Hampshire, Mobbs, & Dalgeish, 2013). One interpretation of our results corroborate these findings showing that baseline WM performance was a statistically significant predictor of WM change following feedback, irrespective of condition, with large effect sizes in both the full sample ($\eta^2=0.215$) and the reactive subsample ($\eta^2=0.195$). In other words, higher baseline WM performance predicted less variability in WM performance following feedback, underscoring its regulatory role in ECF processes. However, there has also been evidence of the contrary—the higher one’s WMC, the more likely their performance is to be negatively impacted by performance pressure but only when the individual is also low in another form of ECF, such as attentional control (Beilock & Carr, 2005; Sattizhan, Moser, & Beilock, 2016). Therefore endeavors to optimize ECF function under stress likely require an examination beyond WM and include other ECFs more directly related to the control of affective processes such as inhibitory control.

In sum, our findings suggest differential effects of feedback on WM function and provide support for the preferential use of positive feedback in the context of learning.
Furthermore, perceptions of recent stress continue to impact WM function irrespective of receiving positive or negative feedback, underscoring the long lasting effects of contextual, non-task-related stress on ECF and echoes the consideration of a students’ social-emotional experiences outside the classroom when evaluating their performance inside the classroom. Whether this effect of non-acute and chronic environmental stress would still impact ECF with greater temporal distance is unknown.
References
Plessow, F., Kiesel, A., & Kirschbaum, C. (2012). The stressed prefrontal cortex and goal-directed behavior; acute psychosocial stress impairs the flexible implementation of task goals. *Experimental brain research, 216*(3), 397-408.
CHAPTER 3

Chronic Stress and later Adolescent Inhibitory Control: Perceived Distress as Mediator
Introduction

Executive control functions (ECF), the set of cognitive functions that includes working memory and inhibitory control, play a central role in our daily functioning and predicting a range of life outcomes (Miyake, Friedman, Emerson, Witzki, & Howarter, 2000): ECF is predictive of performance on a host of complex cognitive tasks in such domains as language comprehension (MacDonald, Just, & Carpenter, 1992; Daneman & Carpenter, 1980), reading abilities (De Jong, 1998; Swanson, 1994), and mathematics (e.g., Bull & Scerif, 2001; Mayringer & Wimmer, 2000; Siegal & Ryan, 1989).

ECF appears to be sensitive to the effects of chronic stress. Exposure to adversity ranging from increased exposure to violence, more chaotic home environments, and fewer material and emotional resources, are experiences that can potentially cause chronic stress (Evans & Kantrowitz, 2002; Evans & Kim, 2010). Some speculate that the cumulative experience of these environmental stressors during childhood can compromise the development of specific neural regions that underlie ECF function (Shonkoff & Phillips, 2000; Lupien, McEwen, Gunnar, & Heim, 2009). Specifically, children in poverty are more likely to experience chronic physical and psychosocial stressors and show developmental differences in their stress response system (Wolf, Nicholls, & Chen, 2008). Childhood SES driven differences in cortisol reactivity (Lupien, King, Meaney, & McEwen, 2000; Lupien, McEwen, Gunnar, & Heim, 2009) are captured as young as seven months of age and are uniquely associated with ECF and academic achievement in pre-kindergarten (Blair, Granger, & Razza, 2005; Blair et al., 2011; Berry, Blair, & Willoughby, & Granger, 2012). In their longitudinal study examining childhood poverty (age 9) and later adult emotion regulation (age 24), Kim
and colleagues (2013) found that cumulative chronic stress mediated the relationship, similar to findings that indicate stress as a mediator between childhood poverty and later ECF (e.g., Evans & Ruller-Rowell, 2013; Blair, 2010). The individual differences in stress responsivity within this low-income population forces a closer examination of the link between environmental stressors (e.g., poverty) and ECF.

Despite the dominant narrative of the deleterious effects of stress, empirical findings point to variability in stress response on ECF (see Shields, Sazma, & Yonelias, 2016 for review). These individual differences may be rooted in differences in stress perception. Varying theories of stress converge on the idea that stress reactivity involves an interaction between a person and his or her environment (Lazarus & Folkman, 1984), therefore, stress perception is likely to vary for any given situation and from person to person. In other words, psychological stress may result from interpretations of a situation and not an objective assessment of experiences. Thus, appraisal may help explain individual differences in cognitive outcomes. Although the relationship between chronic stress and later cognitive outcomes is well studied, the potential mediating role of stress perception has been largely neglected.

In this current study, we aim to test whether distress, the perception of stress as threatening (Kemeny, 2003), mediates the longitudinal relationship between chronic environmental stress and inhibitory control within a low SES population. Prior studies have compared children with very low SES to higher SES counterparts, examining SES as a categorical difference between poor and non-poor children (e.g. Fitzpatrick, 2013). By focusing exclusively on a low SES population, we can focus on differences in stress
exposure and extract important individual differences that may account for cognitive control outcomes.

Figure 3.1. A path diagram modeling the association between distress (age 16) mediating the relationship between environmental stress (age 14) and inhibitory control (age 19).

The aim of the current study is to examine: 1) To what extent does young adolescent chronic environmental adversity lead to differences in late adolescent inhibitory control? Are these effects mediated by perception of distress? We hypothesized that the effect of adverse experiences in early adolescence on inhibitory control is mediated by distress (Figure 3.1).

Method

Participants and Procedures

Participants were 181 Mexican-origin adolescents (M<sub>age</sub>= 17.16 years, SD=.44, 47% girls) enrolled in a sub-study of the California Families Project (CFP), a 10-year, prospective, longitudinal study of 674 Mexican-origin children starting (M<sub>age</sub>= 10.4 years, 49.8% male) who were drawn at random from school rosters during 2006-2008. The sub-study was designed to examine neurobiological mechanisms in the etiology of affective disorders. There were ten waves of data collection starting at approximately age 10 (wave 1) and ending approximately at age 19 (wave 10). In the current analyses, we
included data collected during wave 5 (age 14), wave 7 (age 16), and wave 10 (age 19) given that our variables of interest were collected at those time points.

Measures

Environmental Adversity:

**Neighborhood Criminal Events Scale** (NCEV; Bowen & Bowen, 1999) was administered when adolescents were in fifth grade (aged ~10 years) to assess how frequently they observed various criminal activities in their neighborhood (e.g., “How often were there shootings or stabbings in the past year?”), defined as “the block on which you lie and the blocks on either side of you” (Appendix V). All 10 items were rated on a 4-point scale (1 = almost never or never to 4 = almost always or always). Higher scores indicated greater exposure to crime. The questionnaire demonstrated good internal reliability (alpha = 0.88).

**Neighborhood Quality** was administered to assess the personal evaluation of the attractiveness of the neighborhood (Appendix VI). A typical item is, “Your neighborhood is clean and attractive.” Adolescents rated 6 items as 1 = Not at all true to 4 = Very true. Higher scores indicated higher perceptions of neighborhood quality. The average score was then reversed to reflect *negative* neighborhood quality with higher scores indicating poorer perceptions of neighborhood quality, which was then used as part of the cumulative stressor score. The questionnaire demonstrated excellent internal reliability (alpha=0.93).
Adolescent Perceptions of Discrimination (DSCR; Johnston & Delgado, 2004) was administered to assess adolescents’ perceptions of discrimination against their racial/ethnic group in general as well as their experiences with prejudice and discrimination directed at them (e.g., “You have heard your teachers at school making jokes or saying bad things about [Mexicans/Mexican-Americans]” (Appendix VII). All 19 items were rated on a 4-point scale (1= Not at all true to 4= Very true). Higher scores indicated greater experiences of discrimination. The questionnaire demonstrated adequate internal reliability (alpha = 0.68).

Multicultural Events Scale for Adolescents (MESA; Gonzales, Tein, Sandler, & Friedman, 2001) was administered to assess life events that specifically relate to the lifestyle and experiences of culturally diverse, urban adolescents that specifically relate to “daily hassles” (Appendix VIII). Example items included, “During the past 3 months, people in your family accused you of not being proud of your Mexican background” and “Family members criticized you for speaking English.” Youth rated 40 items to indicate these family cultural conflict events as present (1) or absent (0). Higher scores indicated greater experiences of daily hassles and distress. The questionnaire demonstrated good internal reliability (alpha= 0.70).

Chronic Stress:

For each participant, each of the four risk factors below were coded dichotomously—1 if scores were 1 SD above the mean based on the data distribution of the entire sample, and 0 otherwise. Environmental stress exposure was calculated by summing the dichotomous
scores of all risk factors (range, 0-4). Additive indices of cumulative stress exposure are robust and consistently predict physical and mental health outcomes better than indices of singular stressor exposure or alternative multiple stressor exposure metrics (Evans, Li, & Sepanski, 2013; Kim et al., 2013) and have been argued as a reasonable method in capturing the confluence of physical and psychosocial challenges associated with childhood poverty (Evans & English, 2002). Furthermore, in comparing the effect of stressors in the past year and cumulative life stressors, cumulative stressors had a larger effect on ECF (Hanson et al., 2012).

Perception of Distress:

State-trait anxiety inventory (STAI; Marteau & Bekker, 1992) was administered to gauge state anxiety and emotional distress (Harvey, Nathens, Bandiera, & LeBlanc, 2010; Wager, van Ast, Hughes, Davidson, Lindquist, & Ochsner, 2009) (Appendix IX). Because higher levels of anxiety are associated with threat appraisal style, the STAI has also been used as a measure of threat appraisal (Beck et al., 1985; Rapee & Heimberg, 1997; Sarason & Sarason, 1990; Skinner & Brewer, 1999; Skinner & Brewer, 2002). The scale consists of 20 questions that evaluate how the participant presently feels. A typical item is, “I feel nervous and restless” to which the participant selects from the following 5 point Likert scale (1-Not at all to 5- Extremely). Higher scores indicated greater experiences of anxiety and emotional distress. The dependent variable was the average value for the 20 questions (alpha = 0.84).
Inhibitory Control:

Emotional Go/No-go task was used to assess inhibitory control. Participants were presented pictures of individuals, one of which was the target, and were instructed to press the button in a Go condition while withholding their button press in a No-go condition. Images of fearful and calm facial expressions of 12 unique actors (6 male, 6 female; 3 white and 3 actors of color for each gender) were used as targets and non-targets. All combinations of expressions were used as both targets and non-targets such that in one block, Calm is Go and Fearful is No-go and in the second block, Fearful is Go and Calm is No-go. In each block, the faces show up as Go three times and No-go once. Forty-eight face stimuli were presented for 50 milliseconds each and the intertrial interval was varied between 2000 and 14500 milliseconds. Each run lasted five minutes. The dependent variable was the proportion of accurate responses for No-go trials (alpha: 0.72). It is to note that 150 participants completed the task in the MRI scanner while 32 completed the task on a laptop due to data collection constraints for the imaging study. Environment of task completion (MRI scanner / laptop) is included as a covariate.

Covariates

Family income-to-needs ratio, combined mother-father education level, MASQ (at wave 7), and whether participants completed the Emotional Go/No-go task in or outside the scanner were included as covariates.

Family income-to-needs ratio was calculated by using mothers’ report of their annual income yearly when adolescents were 10-14 years old, to the nearest $5,000 increment (e.g., $30,001-35,000), with $95,001 or more as the highest reporting option. Each
increment corresponded to a number between 1= less than $5,000 and 20= $95,001 or more. Mothers also reported their household roster. Income values were then divided by the income value that corresponded to the poverty line for a family of that size as indicated by the U.S. Census Bureau. For example, in 2010, the poverty threshold for a family of three was $17,552, corresponding to income value 4= $15,001-$20,000, thus, a family of three reporting an income between $15,001 and 20,000 would have an income-to-needs ratio for that year of 1, whereas a family of three reporting an income of $20,001-25,000 would have an income-to-needs ratio of 1.25.

**Mini-Mood and Anxiety Symptom Questionnaire (MASQ; Casillas & Clark, 2001)** was administered to assesses a general distress factor common to both anxiety and depression as well as specific anxiety and depression factors (Appendix X). This 19-item scale measures General Distress (“How much have you felt discouraged”), Anhedonic Depression (“How much have you felt like nothing was very enjoyable”), Anxiety (“How much have you felt keyed up or on edge”), and Anxious Arousal (“Have you had trouble swallowing”). Participants rated how much they “felt or experienced” each symptom “during the past week” using a 5-point scale at age 14 (1=”Not at all”; 2= “A little”; 3=”Somewhat”; 4= “Very much”). The questionnaire demonstrated good reliability (alpha= 0.87).

**Analytic Plan**

To test these hypotheses, we conducted a mediation analysis using ordinary least squared regression (path analysis) via the PROCESS macro in SPSS (Hayes, 2018). This macro uses bootstrapped sampling to estimate the indirect mediation effect of perceived
anxiety and distress on the relationship between environmental stress and inhibitory control. In this analysis, 5,000 bootstrapped samples were drawn with replacement from the dataset to estimate a sampling distribution for the indirect mediation pathway (i.e. the pathway from environmental stress and inhibitory control). Indirect effects and 95% confidence intervals are reported. We reported adjusted $R^2$ values for an estimate of the effect size of the mediator on the cumulative stress and inhibitory control relationship. The predictor was a cumulative stressor metric calculated by adding the instances in which the child >1SD above the mean on a stressor measure (Evans & English, 2002). The dependent variable was the percentage accuracy on No-go trials during the Emotional Go/No-go task. Perception of distress (STAI) was tested as the mediator. Family income-to-needs ratio, parental education, and depression were entered as covariates.
Table 3.1

Univariate Correlations Among Study Variables for Study 3 and Study 4

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<td>1</td>
<td>---</td>
<td>0.087</td>
<td>-0.018</td>
<td>-0.022</td>
<td>-0.042</td>
<td>0.063</td>
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<tr>
<td>2</td>
<td></td>
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<td>0.605**</td>
<td>-0.085</td>
<td>-0.524**</td>
<td>0.105</td>
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<tr>
<td>3</td>
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<td></td>
<td>-0.084</td>
<td>-0.268**</td>
<td>0.033</td>
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<td>4</td>
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<td>-0.012</td>
<td>0.031</td>
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<tr>
<td>Mean</td>
<td>0.49</td>
<td>3.05</td>
<td>2.79</td>
<td>29.22</td>
<td>1.33</td>
<td>0.61</td>
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<tr>
<td>SD</td>
<td>0.63</td>
<td>0.39</td>
<td>0.32</td>
<td>11.27</td>
<td>0.32</td>
<td>0.19</td>
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**Note.** **p<.01. STAI= State-Trait Anxiety Inventory. MASQ= Mini-Mood and Anxiety Symptom Questionnaire. NoGoACC= Performance accuracy during the No-Go trials of the Emotional Go/No-go task.**
Results

One hundred and seventy participants out of 181 provided their education level, income, and household size. Correlations among the remaining study variables are presented in Table 3.1.

We hypothesized that, relative to individuals exposed to less chronic stress, individuals with more chronic stress are more likely to have impaired inhibitory control (Hypothesis 1). Furthermore, we predicted that this effect would be mediated by emotional distress (Hypothesis 2).

To test these hypotheses, we conducted a mediation analysis using ordinary least squares regression (path analysis) via the PROCESS macro in SPSS (Hayes, 2018). Individuals reporting greater chronic stress were no more likely to perform poorly on the inhibitory control task (B= .11, p=0.39) but were more likely to report more emotional distress (B= .29, p=0.0076). Emotional distress, in turn however, did not predict poorer inhibitory control performance (B= .11, p=0.31) (Figure 3.2). A bootstrap confidence interval for the unstandardized indirect effect (IE) based on 5,000 bootstrap samples did include zero (IE=0.03, SE= 0.03, 95% CI= -.01 – .11), providing no evidence for mediation. Even after controlling for MASQ, parental education, and family-income-to-needs-ratio, the direct association between chronic stress and performance on the inhibitory control task did not reach significance (B= .15, p=0.26). Taken together, these findings corroborate the link between chronic stress and perceived distress but are not consistent with the hypothesis that chronic stress and perceived distress are associated with poorer inhibitory control.
Figure 3.2. Results from our model of mediation. **p<0.01
Discussion

The relationship between chronic stress in adolescence and perceived distress was positive: experiences of distress at age 16 increased as a function of environmental adversity during age 14. More surprising, however, was that cumulative chronic environmental stress during adolescence had no detectable direct or indirect impact on later adolescent performance on inhibitory control. A number of assessment and study design issues should be considered when interpreting the current findings.

First, our use of STAI to assess perceptions of distress was not ideal. Although the measure has been used as a measure of distress (Harvey, Nathens, Bandiera, & LeBlanc, 2010; Wager, van Ast, Huges, Davidson, Linquist, & Ochsner, 2009) and select items assess “threat” in The Cognitive Appraisal Scale (Skinner & Brewer, 2002), the measure may reflect trait anxiety even if participants were instructed to report their present perceptions of distress. Furthermore, the aims of STAI were to assess whether distress was perceived following a stressor but because the questionnaire was administered two years after chronic environmental stressors were reported rather than immediately after, the potential causal link is progressively weakened as other plausible mechanisms are introduced.

Our measurement of ECF was also problematic. First, not all the participants performed the Emotional Go/No-go task under the same conditions: 32 participants performed the task on a laptop while 148 participants performed the task in the scanner. Altering the environment in which the participants perform a cognitively demanding task may impact performance. The laptop group performed numerically better on the task (M=15.15, SD=4.78) compared to the scanner group (M=14.64, SD=4.45) though there
was no statistical difference between the performance of the two groups (t(178)=0.58, p=0.56). Second, performance on the Emotional Go/No-go task occurred five years after the measurement of environmental stressors: The temporal distance between the predictor and outcome variables could also attenuate any possible relationship that exists between the two variables. Third, the Emotional Go/No-go task was the sole measure of inhibitory control, which as a construct has shown unreliable coherence between behavioral and self-report measures (Ellingson, Potenza, & Pearlson, 2018) and also demonstrated low reliability in our sample (alpha=0.72). In a meta-analysis of 282 studies of self-control, correlations within and across types of self-control measures were weak and, moreover, correlations between behavioral tasks were smaller compared to self-report (Duckworth & Kern, 2011). Lastly, the direction of the relationship between inhibitory control and perceived distress is arguable. That is, there is literature indicating anxiety (and/or other mental health disorders) is caused by impaired inhibitory control (Abravanel & Sinha, 2015), anxiety causes impaired inhibitory control (Edwards, Edwards, & Lyvers, 2016), or that it moderates the relationship between stress and adversity on poor mental health outcomes (Extremera & Rey, 2015). In our current study, it is possible that experiences of distress would result because of poor inhibitory control but we were unable to test this statistical model given that the measure of inhibitory control did not precede our administration of STAI. The causal direction of the relationship is not clear in the current literature and to address this issue, future work should include a range of cognitive control tasks (e.g., WM, stroop, etc.) as well as questionnaires administered at different time points (e.g., a measurement concurrent with assessment of anxiety to be included as
a control) as well as a measure that assesses stress perception processes more directly (e.g., do X experiences make you feel stressed?).

The aims of the current study were to examine the relationship between chronic stress, inhibitory control, and the potential mediating role of perceived distress. Though our findings did not detect a significant relationship between chronic stress and inhibitory control, chronic stress significantly predicted perceptions of distress. To further examine this relationship, we are prompted to evaluate the link between chronic stress and perceived distress and whether this relationship is moderated by individual beliefs.
CHAPTER 4

Chronic Stress and Distress: Self-Esteem and Optimism as Moderators
Introduction

It is argued that stress perception is a function of an individual’s particular psychological characteristics given a specific set of environmental conditions. That is, threat is not a fixed property of the situation; it is a result of appraisal that assesses the relative match between perceived coping abilities and challenges of the situation (Mason, 1971). Appraisal inherently depends on individual factors—just as the objective challenges posed by the situation are important, personality and other contextually meaningful influences are critical for perception. To examine how varying stress responses arise from stressors, it is crucial to assess an individual’s psychological characteristics that lead them to appraise experiences as threatening.

Optimism is holding positive outlooks on circumstances and appears to be related to challenge states in the context of stress (Tomaka & Blascovich, 1994; Seery, Blascovich, Weisbuch, & Vich, 2004). For example, individuals who score high on a measurement of optimism – “Belief in a Just World” – typically experience challenge states, increased cardiac responding, and enhanced performance when exposed to an ambiguous social stressor compared with those who score low on optimism (Tomaka & Blascovich, 1994). Some hypothesize that these optimistic individuals experience eustress or “challenge” related physiological responses because the positive outlook and affect optimistic individuals hold under stressful conditions may temporarily relieve the cognitive weight caused by the negative experiences of stress (Lazarus, Kanner, & Folkman, 1980). Fredrickson (2001) argues that positive outlooks afford the individual physical, intellectual, and social resources directly influencing secondary appraisal (Do I have the resources to cope with the situation?).
Positive perceptions related to one’s self, or self-esteem, may also influence stress perception. Self-esteem refers to an individual’s evaluation of their self-worth as a person (see, e.g., Donnellan, Trzesniewski, & Robins, 2011). More critically, self-esteem reflects an individual’s subjective perception of themselves rather than an objective evaluation and is commonly conceptualized as the “feeling that one is ‘good enough’” (Rosenberg, 1965, p.31). Affirmation of values and sources of self worth can protect one’s self-image thereby enhancing self-esteem. Experimental studies where participants affirm their personal values, self-affirmation buffers threats to the self in a variety of domains, with several recent studies showing a buffered stress response to a laboratory stress and naturalistic academic stressors (Sherman, Bunya, Creswell, & Jaremka, 2009). Creswell and colleagues (2013) found that self-affirmation improved the problem solving performance in underperforming, stressed individuals and these individuals had significantly lower cortisol responses to stress compared with individuals who did not complete the value affirmation task. Pruessner et al. (1999) found that those with higher self-esteem performed better and had lower cortisol responses to acute stressors. Overall, it can be argued that positive beliefs of one’s self-worth may be related to one’s perception of ability to meet demands of a stressor.

In the current study, we examine the potential moderating role of self-esteem or optimism on environmental stress on perceived distress. According to the self-esteem and optimism literature, I hypothesized that holding positive views of one’s self and the world would attenuate the negative effects of stress on distress and anxiety.
Figure 4.1. Our model of moderation. In the current analyses, we included data collected during wave 5 (age 14), wave 7 (age 16), and wave 10 (age 19).

Method

Materials

Self-esteem. Adolescents reported their global self-esteem at age 16 using the six-item General Self-Esteem scale of the Self-Description Questionnaire II-Short (e.g., “You can do things as well as most people,” “Overall you are a failure [reverse coded]; Marsah, Ellis, Parada, Richards, & Heubeck, 2005) (Appendix XII). The items were rated on a 4-point Likert-type scale, ranging from 1 (not at all true) to 4 (very true), with higher scores indicating higher levels of self-esteem (alpha=0.81).

Dispositional optimism. Dispositional optimism was reported by adolescents at age 16 using the six-item Life Orientation Test (LOT-R; Scheier, Carver, & Bridges, 1994) (Appendix XIII). The LOT-R is the most widely used and well-validated measure of optimism in the psychological literature. Responses ranged from 1= “strongly disagree”
to 4= “strongly agree”. Sample items included “In uncertain times, you usually expect the best” (alpha=0.52).

As an extension of Study 2, the measurement of environmental chronic stress, perceived distress, and covariates are the same as in Study 2.

Results

A moderated regression analysis was conducted to test the hypothesis that the relationship between environmental stress exposure and STAI would be moderated by self-esteem or general optimism. Building off of the mediation model from Study 1, two moderators were both added in this current analysis. The statistical analysis including two moderators simultaneously, as opposed to analyzing two separate models each including one single moderator, in order to examine the effects of each individual variable while accounting for the potential influence of the other. The PROCESS macro Model 2 in SPSS is particularly designed and suited for such double interaction analyses (Hayes, 2018). The interaction term for self-esteem (b=-1.22) explained an additional 5.2% of the variance in STAI, F(1,151)=8.47, p=0.004. The interaction term for optimism (b=1.21) explained an additional 4.7% of the variance in STAI, F(1, 151)=7.61, p=0.006.

To explore these interactions, we plotted the simple slope of stress exposure and STAI at one standard deviation above and below the mean on self-esteem and general optimism. As shown in Figure 4.2, there was a strong negative association between stress exposure and STAI for adolescents high in self-esteem [simple b=-1.22, t(151)=-2.91, p=0.004] and a strong positive association between stress exposure and STAI for adolescents low in self-esteem [simple b=0.45, t(151)=2.11, p=0.03]. As shown in Figure 4.3, there was a strong negative association between stress exposure and STAI for
adolescents with low dispositional optimism \( [\text{simple } b = -0.43, t(151) = -2.40, p = 0.01] \) but no significant association for adolescents with average or high optimism.

In summary, the negative effects of stress experienced during adolescence on feelings of distress and anxiety a few years later were diminished when self-esteem was high but magnified when self-esteem was low. When feelings of positivity are turned outwards in the form of dispositional optimism, having low-optimism diminishes the negative effects of environmental stress on experiences of distress and anxiety. For adolescents with low-optimism, for adolescents low in optimism, there was no link between stress and STAI. In other words, increased environmental stress exposure was associated with lower distress and anxiety, but only for adolescents who had low optimism.

Additional exploratory analyses were conducted on perceived distress measured at a later time point as well as using depression (e.g., MASQ) as the outcome but because none were central to our aims, they can be found in Appendix XIV.
Figure 4.2. Association between amount of environmental stress exposure and STAI for adolescents with high (+1 SD) and low (-1SD) in self-esteem. *p<0.05 **p<0.01

Figure 4.3. Association between amount of environmental stress exposure and STAI for adolescents scoring high (+1 SD) and low (-1SD) in optimism. **p=.01
Discussion

In the present study, we examined the relationship between cumulative environmental stress, perceived distress in an adolescent Mexican-American population, and the influence of self-beliefs. Our findings suggested that high self-esteem buffered against distress outcomes whereas low self-esteem exacerbated distress outcomes, corroborating prior studies that indicate an inverse relationship (Corning, 2002; Frone, 2000; Greenberg et al., 1992; Kernis, Grannemann, & Mathis, 1991).

While self-esteem as a moderator is well studied in the depression literature, its relationship with distress (anxiety) has been examined to a lesser degree. Cross-sectional studies observe an analogous negative relationship, which aligns with our longitudinal findings that high self-esteem is associated with lower perceptions of distress at higher levels of chronic stress, compared to low self-esteem (Lee & Hankin, 2009; Riketta, 2004; Watson et al., 2002; De Jong, Sportel, de Hullu, & Nauta, 2012; Moksnes, Moljord, Espnes, & Byrne, 2010). The stress buffering function of self-esteem, as supported by our findings, indicates that self-esteem might moderate the stress appraisal process. Self-esteem may affect psychological characteristic of the individual, which determines whether a stressor is appraised as stressful (threatening) and, consequently, whether psychological distress is experienced. However, the current study as designed cannot address the appraisal process, only the outcome (e.g., distress).

When focusing on those with high self-esteem, the association between perceived distress and chronic stress appear surprising at first glance. Higher levels of chronic stress were related to lower perceptions of distress rather than higher perceptions of distress, contrary to the notion of “toxic” stress, more is worse not better. These results might
speak to individual differences in the development of resilience. Specifically, the stress inoculation effect or “steeling” theory that mild to moderate stressors can have a positive effect long-term where an individual develops an adaptive stress response and becomes more resilient to the negative effects of future stressors (Khoshaba & Maddi, 1999; Mortimer & Staff, 2004; Boyce & Ellis, 2005; Gunnar, Frenn, Wewerka, & Van Ryzin, 2009; Garmezy, Masten, & Tellegen, 1984; Rutter, 2006; Fergus & Zimmerman, 2005).

The current study furthers the existing literature by examining these processes in Mexican-American adolescents. Psychological research has focused primarily on a relatively homogenous Western, educated, industrialized, rich, and democratic sample, which limits generalizability of findings (Henrich et al., 2010) and, notably, has not reliably replicated to other demographics. For instance, Fischer & Shaw (1999) tested self-esteem, perceived racism, and overall mental health and found that for African Americans, higher levels of self-esteem exhibited poorer mental health as perceptions of discrimination increased whereas those with lower self-esteem showed no such change in their mental health, contrary to their expectations. While findings from our sample of Mexican-American adolescents aligns with the theory that self-esteem buffers against anxiety (Crocker & Park, 2004), the generalizability of existing research on stress and cognitive outcomes should be challenged.

Our positive findings on optimism were contrary to what was predicted but force us to reconsider that “positive” is always protective. Similar to the unexpected findings by Fischer & Shaw (1999), we hypothesized that optimism would function similarly to self-esteem and buffer the effects of stress on perceived distress. Our findings indicate that high optimism showed no such difference in perceived distress even at higher levels
of chronic stress, aligning with literature framing high-optimism as a buffer of stress. More surprisingly, however, low optimism served as a buffer between environmental stress exposure and perceived distress. While this relationship has not been previously documented, the concept defensive pessimism (Norem & Cantor, 1986) which involves individuals to acknowledge and think through their apprehensions, and this process leaves defensive pessimists feeling less anxious and more in control (Norem & Illingworth, 1993). In this sense, setting lower expectations for outcomes can buffer against feelings of distress as exposure to stressors increase. From a self-protective perspective, defensive pessimism can be viewed as a means of protecting one’s experiences of negativity. Alternatively, if one held unwavering optimistic beliefs in the face of increasing stressors, known as unrealistic optimism, research would predict poor outcomes (Weinstein & Klein, 1996). Still, pessimism has been generally linked to a range of poorer outcomes, albeit in a homogenous socio-demographic sample, and thus, the moderating role of optimism in relation to environmental stress and perceived distress in diverse populations should be further examined.

In sum, our findings suggest that self-belief factors such as self-esteem and optimism can moderate the effects of environmental stress on later perception of distress during adolescence. Furthermore, our findings on optimism prompt us to question the simplistic arc of positive psychology and carefully consider individual differences when examining the factors that lead to optimal outcomes under non-optimal circumstances.
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CHAPTER 5

Summary and Conclusion
The effect of stress on cognitive function has long been of scientific interest but literature documenting its effect on ECF highlights discrepancies across and within various domains of ECF. The prominence of individual differences underscores the field’s need to consider the role of the individual when examining the impact of stress. The three studies included in my dissertation were aimed to explore the different aspects of these underlying mechanisms and shed light on the role of individual differences. Below, I summarize the findings from the key studies then discuss the limitations and the major implications that emerged from this work.

**Summary of Findings**

Chapter 2 introduced Study 1, where I investigated the relationship between fictitious feedback (positive or negative) and WM function while assessing a range of affect and self-belief constructs. Using multiple regression, I found a main effect of feedback and that positive feedback resulted in better WM performance compared to negative feedback. Furthermore, for participants reactive to feedback, recent experiences of stress negatively impacted their performance regardless of feedback type indicating two simultaneous main effects of acute and chronic stress on WM. While this study was able to examine the main effect of acute and to a lesser extent chronic (“in the past month”) stress on WM function, the study did not examine the potential role of stress perception.

Chapter 3 extended upon the findings of Study 1 by testing for the potential mediation of perceived stress (i.e. distress) on the effects of chronic stress and inhibitory control. In Study 2, chronic experiences of environmental adversity were examined as a cumulative score for adolescents from a predominantly low-income background. Using
linear regression, I was not able to detect a relationship between chronic stress and performance on an inhibitory control task. Furthermore, I did not find evidence to suggest that the relationship was mediated by perceived distress. However, the link between chronic stress and perceived distress was significant, providing the opportunity to explore our secondary aim of examining the influence of individual beliefs on perceptions of distress.

In Chapter 4, I included the study of individual moderators to further examine the significant relationship between chronic stress and perceived distress. Self-esteem and optimism were found to moderate this relationship and specifically, high self-esteem attenuated the negative effects of chronic stress on perceived distress whereas low self-esteem acerbated these effects. Low optimism also attenuated the negative effects of chronic stress on perceived distress. The findings from this study underscore the impact of an individual’s beliefs on stress perception but call to question whether all positive self-beliefs lead to positive outcomes.

**Discussion & Limitations**

Together, these three studies highlight the variable effects of acute and chronic stress on ECF. Whether these effects are driven by perceptions of distress, however, were not supported with our current findings. But, the finding that chronic stress significantly impacted perceptions of distress and is moderated by individual beliefs validates the proposed use and modification of Lazarus & Folkman’s (1984) theoretical model. More importantly, our study of individual beliefs and perceived distress within a unique population broadens the discussion of protective factors and resilience. Findings from this Mexican-origin adolescent sample align with some of the discrepant findings in literature
regarding the sub-optimal effects of high self-esteem in African Americans (Fischer & Shaw, 1999) and protective effects of pessimism in Asian Americans (Chang, 1996). Perhaps these differences are driven by cultural context and differences in the need for self-enhancement and positivity, values less prominent in cultures less focused on individual achievement and satisfaction relative to American Culture (Norem & Chang, 2002). Thus, when considering the psychological context of the individual when examining stress perception, the socio-cultural context in which the individual is imbedded requires consideration.

The variable effects of stress on ECF might reflect a few notable limitations in the “induction” and assessment of stress in both Study 1 and Study 2. In Study 1, my intention to induce social evaluative stress via feedback (i.e., positive and negative feedback) was not sufficiently effective to alter feelings of distress across the sample as assessed by the self-report questionnaire. For participants who did report changes in distress, however, their experiences of recent stress (in the last month) did negatively impact their WM performance, irrespective of the feedback type assigned pointing, again, to the main effect of acute and “chronic” stress on WM. Second, stress measurement in Study 2 and 3 aimed to encapsulate chronic stress through measures of environmental adversity. The breadth of measurements—from perceived discrimination to neighborhood quality—resulted in little correlation between the measures, thwarting my attempt at creating a latent construct of “stress.” Given the range of physical to psychosocial sources, the methodological issue of assessing environmental stress (also termed “risk” or “adversity” in developmental literature) is common in stress research. Measurement has taken on a variety of forms (see Evans & English, 2000 for review), and because of the
varied sources of stress, I chose to index chronic stress as a *cumulative* construct of multiple physical and psychosocial stressors in hopes of tapping into the confluence of multiple external demands that have led to suboptimal outcomes for children and adolescents in poverty. However, the self-reported levels of chronic stress were low in our sample (M=0.49, range= 0-4), which could reflect measurement issues and/or the possibility that our sample did not experience high levels of chronic stress, despite the expected inverse relationship between SES and stress exposure. Lastly, because stress measures were self-reported, we are unable to identify to what degree this measure is driven by objective versus subjective stress. While work examining the effects of SES on ECF focus on measures similar to those used in Study 2 and Study 3 (e.g., parental education, family income-to-needs ratio), recent work suggests the relevance of *subjective* experiences of SES such that both objective and subjective measures were both independently and positively related to children’s ECF (Ursache, Noble, & Blair, 2015). Similarly, assessments included in our cumulative measure of chronic stress could include both objective and subjective measures of environmental adversity, or at least aim to distinguish the two.

The variable effects of stress on ECF might also reflect limitations in the assessment of ECF in Study 2. The reliability of the Emotional Go/No-go task was low (alpha=0.72) and reflects issues of ECF measurement. Given its complex and multi-faceted nature, measurement of ECF is a pervasive issue with numerous meta-analyses reporting that self-report measures of cognitive control, for example, weakly correlate to behavioral measures or not at all (Duckworth & Kern, 2011; Allom, Panetta, Mullan, & Hagger, 2016), even when comparing between widely used measures of reported self-
control (e.g., the Self-Control Scale) with widely adopted task measures of self-control (e.g., the Stroop task) (Saunders, Milyavskaya, Etz, Randles, & Inzlicht, 2017). Reliability issues with assessments of cognitive control may be in part due its multi-dimensional function; That is, ECF can be roughly categorized by two types of regulatory processes—those that regulate emotions (e.g., emotion regulation; Gross, 1998) and those regulated by emotions (e.g., WM; Campos et al., 2004; Cole et al., 2004). The inclusion of other ECF tasks (and self-reports) focusing on processes regulated by emotions (e.g., WM) may potentially better capture the effect of stress on ECF.

Lastly, my current body of work was not designed to test and address the stress appraisal process. Specifically, we were unable to examine whether an individual appraises a stressor as 1) important to their well-being, 2) whether they have the resources to deal with the stressor, and 3) whether the paired sequence of appraisals lead to either perceived distress or not (aka ‘eustress’).

**Implications**

By highlighting the role of perception, Lazarus & Folkman’s theoretical model of stress appraisal has been instrumental in bringing attention to individual differences in stress outcomes. Such pioneering theoretical efforts laid the groundwork for contemporary empirical work, but dominant theories circulating within the stress and cognition literature reveal a proclivity to perceive negative affect as a cognitive tax and seldom, if ever, as a resource. This bias towards positivity has pervaded our approach to stress such that positive perceptions exclusively, either of ones’ self or of the world, are framed as a resource in optimizing outcomes. Traces of this bias are evident across ECF literature and influenced the conceptual approach to my three studies. But, conflicting
findings make clear that “one size fits all” prescriptions for positive thinking do not actually lead to positive outcomes for all. If psychological resilience is characterized by the capacity of a system to withstand or recover from adversity, one important life outcome that we risk ignoring by focusing exclusively on positivity is the ability to tolerate negative experiences and self-views while we work toward better outcomes. With our social interest in improving cognitive outcomes, more work is needed to understand the individual pathways that lead to differential stress perception and, ultimately, to differential cognitive outcomes. The aim of this body of work is to clarify stress experiences in the context of critical cognitive functions: the collective findings from across these three studies supports the utility of Lazarus & Folkman’s theoretical model of stress appraisal and the need to spotlight the individual to capture the diversity of ways in which people achieve a diverse array of positive outcomes.
References


Appendix I

Perceived Stress Scale (PSS-4)

1. In the last month, how often have you felt that you were unable to control the important things in your life?
   1---------------------------2----------------------------------3----------------------------------4----------------------------------5
   never almost never sometimes fairly often very often

2. In the last month, how often have you felt confident to handle your personal problems?
   1---------------------------2----------------------------------3----------------------------------4----------------------------------5
   never almost never sometimes fairly often very often

3. In the last month, how often have you felt that things were going your way?
   1---------------------------2----------------------------------3----------------------------------4----------------------------------5
   never almost never sometimes fairly often very often

4. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
   1---------------------------2----------------------------------3----------------------------------4----------------------------------5
   never almost never sometimes fairly often very often

Reverse score Q2 & 3 (1-5, 2-4, 3-3); average 4 items
Higher score indicates higher levels of perceived lack of control.
Appendix II
State-Trait Anxiety Inventory (STAI-6)

Please answer the following about yourself as best as you can.

How **stressed** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

How **calm** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

How **tense** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

How **upset** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

How **relaxed** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

How **content** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

How **worried** do you feel right now:
1------------------------25--------------------------50--------------------------75--------------------------100
Not at all slightly moderate very extremely

Reverse score Q2, 5, 6 (1-5, 2-4, 3-3, 4-2, 5-1); average 7 items
Higher score indicates higher levels of perceived stress/anxiety
Appendix III
Self Concept of Ability

1. How good are you at doing cognitively challenging tasks today (e.g. IQ tests)?

1
------------
25
---------------
50
------------------
75
-------------------
100

poor           fair         good           very good         excellent

2. How good are you at doing cognitively challenging tasks in general (e.g. IQ test)?

1
----------------------
25
----------------------
50
----------------------
75
----------------------
100

poor           fair         good           very good         excellent

3. Compared to other students at your school, how good are you at doing cognitively challenging tasks today (e.g. IQ test)?

1
-------------
25
-------------
50
-------------
75
-------------
100

much worse     somewhat worse  the same         somewhat better    much better

4. Compared to other students at your school, how good are you at doing cognitively challenging tasks in general (e.g. IQ test)?

1
-------------
25
-------------
50
-------------
75
-------------
100

much worse     somewhat worse  the same         somewhat better    much better

Higher scores indicate higher self-concept of ability.
Appendix IV

**WM Accuracy by round**

![](image)

Note. 2-back performance by round following feedback.
Appendix V
Neighborhood Criminal Events Scale

| vios01 | Violent crimes including stabbings, shootings, violent assaults?  
|        | Crímenes violentos, incluyendo cuchilladas, balaceras, y asaltos violentos? |
| vios02 | Kids taking others' wallets or purses?  
|        | Niños llevándose carteras o bolsas de otros? |
| vios03 | Kids damaging property?  
|        | Niños dañando propiedad? |
| vios04 | Kids throwing trash?  
|        | Niños tirando basura? |
| vios05 | Gang fights?  
|        | Pleitos de pandillas? |
| vios06 | Kids using illegal drugs?  
|        | Niños usando drogas? |
| vios07 | Kids drinking alcohol?  
|        | Niños tomando alcohol? |
| vios08 | Kids spraying graffiti?  
|        | Niños pintando graffiti (en las paredes, cosas, u otras lugares)? |
| vios09 | Groups of kids hanging around who make you feel unsafe?  
|        | Grupos de muchachos pasando el tiempo, que te dan miedo? |
| vios10 | **Kids selling illegal drugs?  
|        | Niños vendiendo drogas? |

How often did the following things happen in your school in the past year?

En el último año, ¿qué tan seguido pasó lo siguiente en tu escuela?

Response Categories:
1 = Almost never or never/ Casi nunca o nunca
2 = Sometimes/ A veces
3 = A lot of the time/ Muchas veces
4 = Almost always or always/ Casi siempre o siempre
8 = Refusal
9 = Don’t know

Average 10 items
Higher score indicates higher exposure of criminal activity
Appendix VI
Neighborhood Quality Evaluation Scale

Tell me how much the following statements are true about your neighborhood.
Dime que tan cierta es cada una de estas frases acerca de tu vecindad.

<table>
<thead>
<tr>
<th>Response Categories:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Not at all true/ Nada cierto</td>
</tr>
<tr>
<td>2= Somewhat true/ Algo cierto</td>
</tr>
<tr>
<td>3= Mostly true/ Cierto</td>
</tr>
<tr>
<td>4= Very true/ Muy cierto</td>
</tr>
<tr>
<td>8= Refusal</td>
</tr>
<tr>
<td>9= Don’t know</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>nqua01</th>
<th>Your neighborhood is clean and attractive.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tu vecindad esta limpia y atractiva.</td>
</tr>
<tr>
<td>nqua03</td>
<td>You think this neighborhood is a good place to live.</td>
</tr>
<tr>
<td></td>
<td>Piensas que tu vecindad es un buen lugar para vivir.</td>
</tr>
<tr>
<td>nqua06</td>
<td>People in your neighborhood take good care of their homes and property.</td>
</tr>
<tr>
<td></td>
<td>La gente en tu vecindad cuida muy bien a sus casas y propiedad.</td>
</tr>
<tr>
<td>nqua07</td>
<td>It is safe in your neighborhood.</td>
</tr>
<tr>
<td></td>
<td>Tu vecindad es segura.</td>
</tr>
<tr>
<td>nqua11</td>
<td>Overall, you are satisfied with your neighborhood.</td>
</tr>
<tr>
<td></td>
<td>En general, estás satisfecho/a con tu vecindad.</td>
</tr>
<tr>
<td>nqua12</td>
<td>Overall, your neighbors are good people.</td>
</tr>
<tr>
<td></td>
<td>En general, tus vecinos son buena gente.</td>
</tr>
</tbody>
</table>

All 6 items were reverse scored and average as an index of poor neighborhood quality. Higher score indicates lower levels of perceived quality.
## Adolescent Perceptions of Discrimination

For the next set of questions, I am interested in your experiences with other people, in your neighborhood and at school. Tell me how true the following statements are for you.

Para las siguientes preguntas estoy interesado/a en tus experiencias con otras personas, en tu vecindad y en tu escuela. Dime que tan ciertas son para ti las siguientes frases.

### Response Categories:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not at all true/ Nada cierto</td>
</tr>
<tr>
<td>2</td>
<td>Somewhat true/ Algo cierto</td>
</tr>
<tr>
<td>3</td>
<td>Mostly true/ Cierto</td>
</tr>
<tr>
<td>4</td>
<td>Very true/ Muy cierto</td>
</tr>
<tr>
<td>5</td>
<td>Refusal</td>
</tr>
<tr>
<td>6</td>
<td>Don’t know</td>
</tr>
</tbody>
</table>

### dscr01
Your teachers think all [Mexicans/Mexican-Americans] are alike.

Tus maestros piensan que todos los [Mexicanos/México-Americanos] son iguales.

### dscr02
You have heard kids at school making jokes or saying bad things about [Mexicans/Mexican-Americans].

Has oído a niños en tu escuela haciendo bromas o diciendo cosas malas de los [Mexicanos/México-Americanos].

### dscr03
Kids at school think bad things about [Mexicans/Mexican-Americans].

Niños en la escuela piensan mal sobre los [Mexicanos/México-Americanos].

### dscr04
Your teachers dislike [Mexicans/Mexican-Americans].

A tus maestros no les gustan los [Mexicanos/México-Americanos].

### dscr05
Kids at school dislike [Mexicans/Mexican-Americans].

A los niños de la escuela no les gustan los [Mexicanos/México-Americanos].

### dscr06
You have heard your teachers at school making jokes or saying bad things about [Mexicans/Mexican-Americans].

Has oído a tus maestros en tu escuela haciendo bromas o diciendo cosas malas de los [Mexicanos/México-Americanos].

Higher score indicates higher levels of perceived discrimination.
Appendix VIII
Multi-Cultural Events for Adolescents (MESA, 40 items)

Now I'm going to read a list of events that sometimes happen to children. Please tell me whether or not each of these events happened to you during the past 3 months.

Ahora voy a leer una lista de eventos que algunas veces le suceden a los niños. Por favor dime si cada uno de estos eventos te sucedió durante los últimos tres meses.

Response Categories:
1 = Yes/ si
2 = No/No
8 = Refusal
9 = Don’t know

<p>| mesa01 | During the past 3 months, your parent lost a job. Durante los últimos tres meses, uno de tus papás perdió su trabajo. |
| mesa02 | During the past 3 months, your parent talked about having serious money problems. Durante los últimos tres meses, uno de tus papás habló acerca de tener problemas serios de dinero. |
| mesa03 | Your family had to stay in a homeless shelter or public place. Tu familia tuvo que quedarse en un refugio para personas sin hogar o en un lugar público. |
| mesa04 | Things in your home did not work the way they should like no water, no electricity, or things falling apart. Las cosas en tu hogar no funcionaron en la manera como debían de ser, por ejemplo: no hubo agua, no hubo electricidad, las cosas se escompusieron, etc. |
| mesa05 | Family members could not go someplace they needed to go like work, school, or the doctor because they did not have transportation. Los miembros de la familia no pudieron ir a algún lugar donde necesitaban ir, por ejemplo: al trabajo, a la escuela, con el médico, etc. porque no tenían transporte. |
| mesa06 | Your parent was upset because he or she could not find work. Uno de tus papás estuvo triste porque no podía encontrar trabajo. |
| mesa07 | You had to wear clothes that were dirty, worn out, or did not fit. Tuviste que usar ropa que estaba sucia, vieja, o que no te quedaba. |
| mesa08 | You had to work to support other family members. Tuviste que trabajar para mantener otros miembros de la familia. |
| mesa09 | You had to go without a meal because your family did not have enough money. Te tuviste que quedar sin comer porque tu familia no tenía suficiente dinero. |
| mesa10 | You had to do almost all the cooking, cleaning or childcare in your home because your parent had to work. |</p>
<table>
<thead>
<tr>
<th>Mesa</th>
<th>English</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>During the past 3 months, a close friend died.</td>
<td>Durante los últimos tres meses, un amigo/a íntimo/a murió.</td>
</tr>
<tr>
<td>12</td>
<td>You were pressured to do drugs, smoke, or drink alcohol.</td>
<td>Te presionaron a tomar drogas, fumar, o beber alcohol.</td>
</tr>
<tr>
<td>13</td>
<td>You were pressured against your will to join a gang.</td>
<td>Te presionaron, contra tu voluntad, a entrar a una pandilla.</td>
</tr>
<tr>
<td>14</td>
<td>Your close friend(s) got drunk or high.</td>
<td>Tu amigo o tus amigos íntimos se emborracharon o se drogaron.</td>
</tr>
<tr>
<td>15</td>
<td>Your friends criticized you for hanging out with other ethnic or racial groups.</td>
<td>Tus amigos te criticaron por juntarte con otros grupos étnicos o con grupos de otras razas.</td>
</tr>
<tr>
<td>16</td>
<td>Other kids said mean or bad things to you.</td>
<td>Otros niños te dijeron cosas crueles o malas.</td>
</tr>
<tr>
<td>17</td>
<td>Other kids told mean stories or lies about you.</td>
<td>Otros niños contaron malas historias o dijeron mentiras acerca de ti.</td>
</tr>
<tr>
<td>18</td>
<td>Other kids stole things from you.</td>
<td>Otros niños te robaron cosas.</td>
</tr>
<tr>
<td>19</td>
<td>Other kids broke or destroyed your things.</td>
<td>Otros niños quebraron o destruyeron tus cosas.</td>
</tr>
<tr>
<td>20</td>
<td>Other kids made fun of the way you look.</td>
<td>Otros niños se burlaron de como te miras.</td>
</tr>
<tr>
<td>21</td>
<td>During the past 3 months, a friend that you trusted did not keep a secret.</td>
<td>Durante los últimos tres meses, un amigo en quien confiabas no guardó un secreto.</td>
</tr>
<tr>
<td>22</td>
<td>You had a disagreement or fight with a close friend.</td>
<td>Tuviste un desacuerdo o pleito con un amigo íntimo o una amiga íntima.</td>
</tr>
<tr>
<td>23</td>
<td>Other kids wanted to fight with you or tried to fight with you.</td>
<td>Otros niños quisieron pelear contigo o trataron de pelear contigo.</td>
</tr>
<tr>
<td>24</td>
<td>A close friend had a serious emotional problem.</td>
<td>Un amigo íntimo o una amiga íntima tuvo un problema emocional serio.</td>
</tr>
<tr>
<td>25</td>
<td>A family member got upset at you for not participating in the family's cultural or traditions.</td>
<td>Un miembro de la familia se disgustó contigo por no participar en las tradiciones culturales o religiosas de la familia.</td>
</tr>
<tr>
<td>26</td>
<td>A family member criticized you for hanging out with people of a different race or culture.</td>
<td>Un miembro de la familia te criticó por juntarte con personas de diferente cultura o raza.</td>
</tr>
<tr>
<td>27</td>
<td>During the past 3 months, people in your family accused you of not being proud of your Mexican background.</td>
<td>Durante los últimos tres meses, personas en tu familia te acusaron de no estar orgulloso/a de tu herencia Mexicana.</td>
</tr>
<tr>
<td>28</td>
<td>You disagreed with family members because they wanted you to do things</td>
<td>You disagree with family members because they wanted you to do things</td>
</tr>
<tr>
<td>90</td>
<td>the Mexican/Latino way. Estuviste en desacuerdo con tus familiares debido a que ellos querian que hicieras las cosas al estilo Mexicano o Latino.</td>
<td></td>
</tr>
<tr>
<td>mesa29</td>
<td>You had a serious disagreement or fight with a parent. Tuviste un desacuerdo serio o pleito con uno de tus padres.</td>
<td></td>
</tr>
<tr>
<td>mesa30</td>
<td>Your parents had a serious disagreement or fight with each other. Tus padres tuvieron un desacuerdo serio o un pleito entre ellos.</td>
<td></td>
</tr>
<tr>
<td>mesa31</td>
<td>Other members of your family or people you live with had a serious disagreement or fight. Otros miembros de tu familia o las personas con las que vives tuvieron un desacuerdo serio o pleito.</td>
<td></td>
</tr>
<tr>
<td>mesa32</td>
<td>Members of your family hit or hurt each other. Miembros de tu familia se golpearon o lastimaron entre ellos.</td>
<td></td>
</tr>
<tr>
<td>mesa33</td>
<td>During the past 3 months, members of your family refused to speak to each other. Durante los últimos tres meses, miembros de tu familia se negaron a hablarse unos a otros.</td>
<td></td>
</tr>
<tr>
<td>mesa34</td>
<td>Family members criticized you for speaking English. Miembros de tu familia te criticaron por hablar inglés.</td>
<td></td>
</tr>
<tr>
<td>mesa35</td>
<td>Other kids put you down for not speaking Spanish or not speaking it well. Otros niños te hicieron sentir menos o inferior por no saber hablar español o no hablarlo bien.</td>
<td></td>
</tr>
<tr>
<td>mesa36</td>
<td>A teacher put you down for not speaking English or not speaking it well. Un/una maestro/maestra te hizo sentir menos o inferior por no hablar inglés o no hablarlo bien.</td>
<td></td>
</tr>
<tr>
<td>mesa37</td>
<td>You had a hard time doing things because you do not speak Spanish well. Tuviste dificultad haciendo cosas porque no hablas bien el español.</td>
<td></td>
</tr>
<tr>
<td>mesa38</td>
<td>During the past 3 months, other kids put you down for not speaking English or not speaking it well. Durante los últimos tres meses, otros niños te hiciereon sentir menos o inferior por no hablar inglés o por no hablarlo bien.</td>
<td></td>
</tr>
<tr>
<td>mesa39</td>
<td>During the past 3 months, you had a hard time doing things because you do not speak English well. Durante los últimos tres meses, tuviste dificultad haciendo cosas porque no hablas bien el inglés.</td>
<td></td>
</tr>
<tr>
<td>mesa40</td>
<td>You were criticized for speaking Spanish or speaking English with an accent. Te criticaron por hablar en español o por hablar el inglés con un acento.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix IX
STAI (20 items)

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the number to the right of the statement to indicate how you feel right now, that is, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

1 = NOT AT ALL
2 = SOMEWHAT
3 = MODERATELY SO
4 = VERY MUCH SO

1. I feel calm……………………………………………………. 1     2  3  4
2. I feel secure………………………………………………… 1     2  3  4
3. I am tense…………………………………………………… 1     2  3  4
4. I feel strained……………………………………………… 1     2  3  4
5. I feel at ease………………………………………………… 1     2  3  4
6. I feel upset………………………………………………….. 1     2  3  4
7. I am presently worrying over possible misfortunes… 1     2  3  4
8. I feel satisfied……………………………………………… 1     2  3  4
9. I feel frightened……………………………………….... 1     2  3  4
10. I feel comfortable……………………………………….. 1     2  3  4
11. I feel self-confident…………………………………….. 1     2  3  4
12. I feel nervous…………………………………………….. 1     2  3  4
13. I feel jittery………………………………………………... 1     2  3  4
14. I feel indecisive………………………………………… 1     2  3  4
15. I feel relaxed……………………………………………… 1     2  3  4
16. I feel content……………………………………………… 1     2  3  4
17. I feel worried……………………………………………… 1     2  3  4

91
18. I feel confused........................................ 1 2 3 4
19. I feel steady........................................... 1 2 3 4
20. I feel pleasant........................................ 1 2 3 4

Reverse score: 1, 2, 5, 8, 10, 11, 15, 16, 19, 20. Average all 20 items. Higher score indicates greater anxiety.
<table>
<thead>
<tr>
<th>Question</th>
<th>Spanish</th>
</tr>
</thead>
<tbody>
<tr>
<td>How much have you felt or experienced each of the following during the past week?</td>
<td>¿Cuánto ha sentido o ha experimentado lo siguiente en la última semana?</td>
</tr>
<tr>
<td>Response Categories</td>
<td></td>
</tr>
<tr>
<td>1 = Not at all/ Nada</td>
<td></td>
</tr>
<tr>
<td>2 = A little/ Un poco</td>
<td></td>
</tr>
<tr>
<td>3 = Somewhat/ Algo</td>
<td></td>
</tr>
<tr>
<td>4 = Very much (a lot)/ Bastante</td>
<td></td>
</tr>
<tr>
<td>5 = Extremely: Asked for Child only at Wave 5 only</td>
<td></td>
</tr>
<tr>
<td>8 = Refusal</td>
<td></td>
</tr>
<tr>
<td>9 = Don’t know</td>
<td></td>
</tr>
<tr>
<td>masq01 How much have you felt depressed?</td>
<td>¿Cuánto se ha sentido deprimida?</td>
</tr>
<tr>
<td>masq02 How much have you felt discouraged?</td>
<td>¿Cuánto se ha sentido sin ánimo/desalentada?</td>
</tr>
<tr>
<td>masq03 Felt hopeless?</td>
<td>¿Se ha sentido sin esperanzas?</td>
</tr>
<tr>
<td>masq04 Felt like a failure?</td>
<td>¿Se ha sentido como un fracaso?</td>
</tr>
<tr>
<td>masq05 How much have you felt worthless?</td>
<td>¿Cuánto ha sentido despreciable?</td>
</tr>
<tr>
<td>masq06 Felt withdrawn from other people?</td>
<td>¿Se ha sentido alejada de otras personas?</td>
</tr>
<tr>
<td>masq07 Felt like nothing was very enjoyable?</td>
<td>¿Se ha sentido como si nada le agradaba?</td>
</tr>
<tr>
<td>masq14 Felt tense or high strung?</td>
<td>¿Se ha sentido nerviosa o tensa?</td>
</tr>
<tr>
<td>masq15 How much have you felt uneasy?</td>
<td>¿Cuánto se ha sentido incómoda?</td>
</tr>
<tr>
<td>masq16 Felt keyed up or on edge?</td>
<td>Se ha sentido con los nervios de punta?</td>
</tr>
<tr>
<td>masq17 Felt dizzy or lightheaded?</td>
<td>¿Se ha sentido mareada</td>
</tr>
<tr>
<td>masq18 Been trembling or shaking?</td>
<td>¿Se ha sentido temblorosa?</td>
</tr>
<tr>
<td>masq19 Were your hands shaky?</td>
<td>¿Han estado sus manos temblando?</td>
</tr>
<tr>
<td>masq20 Have you had trouble swallowing?</td>
<td>¿Ha tenido problemas tragando algo?</td>
</tr>
<tr>
<td>masq21 Have you been short of breath?</td>
<td>Have you been short of breath?</td>
</tr>
</tbody>
</table>
| masq22 | Have you had a very dry mouth?  
|        | ¿Ha tenido la boca muy seca? |
| masq23 | Have your muscles twitched or trembled?  
|        | ¿Ha sentido un tic nervioso en sus músculos (movimiento de músculos repentina)? |
| masq24 | Have you had hot or cold spells?  
|        | ¿Ha tenido sofocos de calor o frió? |
| masq25 | Have your hands been cold or sweaty?  
|        | ¿Han estado sus manos frías o sudorosas? |

All 19 items were averaged. Higher scores indicated greater feelings of depression.
# Appendix XI
Rosenberg self-esteem scale

Tell me how true the following statements are for you.

Dime que tan ciertas son para ti las siguientes frases.

<table>
<thead>
<tr>
<th>Response Categories:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Totally disagree/ Totalmente en desacuerdo</td>
<td></td>
</tr>
<tr>
<td>2 = Disagree/ En desacuerdo</td>
<td></td>
</tr>
<tr>
<td>3 = Agree/ De acuerdo</td>
<td></td>
</tr>
<tr>
<td>4 = Totally agree/ Totalmente acuerdo</td>
<td></td>
</tr>
<tr>
<td>8 = Refusal</td>
<td></td>
</tr>
<tr>
<td>9 = Don’t know</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>rose01</th>
<th>On the whole, I am satisfied with myself. En general, estoy satisfecho/a conmigo mismo</th>
</tr>
</thead>
<tbody>
<tr>
<td>rose02</td>
<td>At times I think I am no good at all. A veces pienso que no soy nada bueno/a</td>
</tr>
<tr>
<td>rose03</td>
<td>I feel that I have a number of good qualities. Creo que tengo algunas buenas cualidades</td>
</tr>
<tr>
<td>rose04</td>
<td>I am able to do things as well as most other people Soy capaz de hacer las cosas tan bien como la mayoría de otras personas</td>
</tr>
<tr>
<td>rose05</td>
<td>I feel I do not have much to be proud of. Siento que no tengo mucho de que sentirme orgulloso/a</td>
</tr>
<tr>
<td>rose06</td>
<td>I certainly feel useless at times. Por seguro, a veces me siento inútil</td>
</tr>
<tr>
<td>rose07</td>
<td>I feel that I am a person of worth, at least on an equal plane with others. Creo que soy una persona de valor, por lo menos igual que otros</td>
</tr>
<tr>
<td>rose08</td>
<td>I wish I could have more respect for myself. Deseo que me respetará más a mí mismo/a</td>
</tr>
<tr>
<td>rose09</td>
<td>All in all, I am inclined to feel that I am a failure. Tomando todo en cuenta, estoy inclinado/a sentirme que soy un fracaso</td>
</tr>
<tr>
<td>rose10</td>
<td>I take a positive attitude toward myself. Tomo una actitud positiva hacia mí mismo/a</td>
</tr>
</tbody>
</table>

Reverse score Q2, Q5-6, Q8-9; average 10 items
Higher score indicates higher levels of self-esteem
Appendix XII  
Dispositional Optimism

How much do you agree or disagree with the following statements about yourself? 
¿Cuánto está de acuerdo con las siguientes frases sobre sí mismo?

<table>
<thead>
<tr>
<th>Response Categories:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 = Strongly disagree/ Muy en desacuerdo</td>
</tr>
<tr>
<td>2 = Disagree/ En desacuerdo</td>
</tr>
<tr>
<td>3 = Agree/ De acuerdo</td>
</tr>
<tr>
<td>4 = Strongly agree/ Muy de acuerdo</td>
</tr>
<tr>
<td>8 = Refusal</td>
</tr>
<tr>
<td>9 = Don’t know</td>
</tr>
</tbody>
</table>

| optm01 | In uncertain times, you usually expect the best.  
Cuando la vida parece incierta, usted usualmente espera lo mejor. |
| optm02 | If something can go wrong for you, it will.  
Si algo le puede salir mal, así sucederá. |
| optm03 | You are always optimistic about your future.  
Siempre se siente optimista acerca del futuro. |
| optm04 | You hardly ever expect things to go your way.  
Casi nunca espera que las cosas salgan como usted quiere. |
| optm05 | You rarely count on good things to happen to you.  
Rara vez cuenta con que le van a pasar cosas buenas. |
| optm06 | Overall, you expect more good things to happen to you than bad.  
En general, usted espera que le van a pasar más cosas buenas que malas. |

Reverse score Q2, Q4-5; average 6 items  
Higher score indicates higher levels of dispositional optimism.
Appendix XIII
Additional Analyses for Moderators

The following exploratory analyses were all conducted using ordinary least squares regression (path analysis) via the PROCESS macro in SPSS (Hayes, 2018).

We were interested to see if self-esteem and optimism would continue to moderate the effect of chronic stress on a later time point of perceived distress (age 18). Neither the interaction term for self-esteem ($F(1,133)=2.13, p=0.14$) nor optimism ($F(1,133)=0.27, p=0.59$) were statistically significant in moderating the relationship between chronic stress and perceived distress measured at age 18.

We were also interested to see if self-esteem and optimism would moderate the effect of chronic stress on depression, as measured by the MASQ. We included both MASQ measured at wave 7 (age 16) and wave 9 (age 18).

MASQ7 as outcome: Self-esteem was not a statistically significant moderator ($F(1,136)=2.23, p=0.13$) but optimism was statistically significant moderator ($F(1,136)=5.44, p=0.02$). For those with low optimism ($b=0.31$), greater exposure to stress leads to greater depression.

MASQ9 as outcome: Neither self-esteem ($F(1,134)=0.66, p=.41$) nor optimism ($F(1,134)=1.68, p=0.19$) were statistically significant in moderating the relationship between chronic stress and depressions measured when the participant was approximately age 18.