Multi-Faceted Emotion Regulation, Stress, and Affect in Mothers of Young Children

Kirby Deater-Deckard, **Mengjiao Li**, and **Martha Ann Bell**
Department of Psychology, Virginia Tech

Abstract

We tested a novel multi-component emotion self-regulation (ER) construct that captured physiological (vagal tone), cognitive (reappraisal), and temperament (effortful control) aspects of ER as a moderator of the link between more stressors and greater negative/less positive affectivity. A socioeconomically diverse sample of 151 women with young children completed questionnaires and a laboratory visit (including cognitive and parent-child interaction tasks, and vagal tone measurement). Women with more stressors had more negative affectivity and less positive affectivity. Furthermore, for negative affectivity only, having more stressors was substantially associated with negative affectivity but only among women with the lowest ER. This pattern was evident for the composite as well as individual indicators of ER. Results were not attributable to individual differences in executive function. Findings are discussed in light of the diathesis-stress model of stress and coping.

Keywords

Introduction

Individuals with strong emotion regulation (ER) capacities modulate their emotional responses in ways that promote healthier internal emotional lives (i.e., less anxiety, depression, and hostility) and clearer communication of their emotions in their relationships. ER may be most crucial when chronic stressors cause sustained emotional arousal that otherwise would interfere with healthy functioning. ER has been operationalized using physiology (i.e., vagal tone), cognition (i.e., reappraisal of situations and emotions), and temperament (i.e., effortful control), but these are never examined together which limits our understanding of how ER "works". Our goal in the current study was to integrate indicators of ER to rigorously examine ER as a resiliency factor for women facing multiple chronic socioeconomic and caregiving role stressors.

Address correspondence to Kirby Deater-Deckard, Department of Psychology, Virginia Tech, 109 Williams Hall (0436), Blacksburg, VA, 24061; Tel: (540) 231-0973; kirbydd@vt.edu

Stress and Emotionality

In the current study, we used a stress homeostasis framework to conceptualize the roles of chronic stressors, emotionality, and emotion regulation that are brought to bear to maintain biological and psychological functioning while minimizing psychological and physiological costs to the individual (Lazarus, 2006; Selye, 1956). According to this framework, negative emotions arise to motivate change in behavior when homeostasis is threatened by potential punishments or losses of rewards in the environment. "Stressors" are events (brief or chronic) that signal potential risks or reward losses. When appraised as threatening and beyond the capacity to cope, emotional distress and physiological arousal fuel a variety of strong defensive negative emotions (Lazarus, 2006).

Prior literature has emphasized the salience of discrete life events (e.g., divorce, loss a job) in contributing to the negative psychological and physical outcomes (Hammen, 2005), but chronic stressors are particularly troubling because their sustained effects cause physical and mental illnesses (McEwen, 1998). Chronic stress arises from a wide array of contextual and personal factors, such as mental and physical health problems, lack of access to socioeconomic resources, caregiving and work stress, lack of control and chaos in the environment, poor family and personal relationships, geopolitical pressures and conflicts, and the acute and chronic phases of natural and man-made disasters (Collins, Baum, & Singer, 1983; Hammen, Kim, Eberhart, & Brennan, 2009). Although there is little research on the matter, chronic stressors may operate via reduced positive affectivity. Frequent daily hassles and chronic health problems are associated with transient and stable positive affect (Rocke, Li, & Smith, 2009; Stawski, Sliwinski, Almeida, & Smyth, 2008; van Eck, Nicolson, & Berkhof, 1998). Therefore, in the current study we sought to examine chronic stressors and negative as well as positive affectivity.

To understand the stress process, examination of context and social roles are essential (Lazarus & DeLongis, 1983). For adults, the most salient context and role stressors are socioeconomic/resource attainment (e.g., barriers to employment, adequate income, and educational attainment) and family/parenting risks (e.g., single parenthood, caring for a child with behavioral problems) (Folkman, Lazarus, Pimley & Novacek, 1987). Family economic hardship, household and neighborhood "chaos" (i.e., lack of routines, noise, crowding), lack of access to employment and educational attainment, and parenting stress arising from caregiving demands all convey risks to physical and mental health (Conger et al., 2002; Evans & Wachs, 2009), in part due to their effects on high negative and low positive affectivity (Day & Livingstone, 2001). Such processes may be particularly salient for women, who are more likely than men to appraise threatening events as more stressful and less controllable, and experience more distress in response to chronic stressors (Oman & King, 2000; Matud, 2004). Thus, in the current study we focused on chronic stressors for women with young children, including: low maternal education, low paternal education, paternal unemployment, household chaos, single parenting, caring for more than three children, caring for a child with a disability, and caring for a child with behavioral or emotional problems.

Regulation of Emotion

In considering the links between chronic stressors and affect, there are rapid "automatic" affective *reactions* as well as the slower and more effortful *regulation* of those reactions that must be considered (Rothbart & Bates, 1998). In the current study, we consider emotion self-regulation (ER) as a broad construct involving various inter-related components of emotions, thoughts, behaviors, and physiology that are integrated to account for stable individual differences in regulatory capacity. A broad view is useful because ER has been operationalized in a variety of ways, typically within specific domains such as construal (e.g., reappraisals of situations and emotions; Gross, 1998), temperament and personality (e.g., effortful control; Evans & Rothbart, 2007), and physiology (e.g., vagal tone; Porges, 1995). All of these components matter and should be considered simultaneously as part of a rubric of inter-related components of ER—something that is rarely done. Our major goal in the current study was to use a three-pronged ER construct spanning multiple domains of cognitive, emotion, and physiological regulation, to better capture the depth and breadth of individual differences: effortful control (self-reported); vagal tone (ECG recording); and reappraisal of emotionally salient experiences (self-reported).

Effortful control (EC), the first component of ER we consider, is a temperament factor comprised of facets of self-regulation of emotions, thoughts and behaviors (Evans & Rothbart, 2007). EC represents tendencies to control attention, inhibit impulses, and to do things that one does not want to do but that need to be done. EC is the temperament-based foundation of the broader personality trait of conscientiousness, which includes self-regulation and self-control of affective states along with other aspects of organized and socially appropriate behavior (Rothbart, Ahadi, & Evans, 2000). Vagal tone, the second component of ER we examine, represents function of the vagus nerve in modulating autonomic physiological and emotional reactivity to produce homeostasis (Porges, Doussard-Roosevelt & Maiti, 1994). The vagus nerve controls heart activity by increasing heart rate during challenging states, and decreasing heart rate to return to a calm resting state (Porges, 2003). Maintaining physiological homeostasis is one of the essential functions of the autonomic nervous system (ANS), as the central and peripheral nervous systems work to be vigilant enough to notice real threats when they arise while having ready any resources needed for responding to these threats or stressors more generally (Selye, 1956). The third component of ER we consider is cognitive reappraisal of situations and emotions. Through actively reinterpreting and neutralizing emotional stimuli, cognitive reappraisal helps regulate the impact of internal and external stressors on emotion with concomitant reductions in negative affectivity (Gross, 1998; Nezlek & Kuppens, 2008). Experimental and correlational findings indicate reappraisal leading to more effective cognitive, affective and physiological emotion regulation (Gross & John, 2003; Richards & Gross, 2000).

According to the diathesis stress model, personal attributes (e.g., temperamental, cognitive and physiological factors) interact with stressors, to moderate the effect of stressful events on mental health and psychological well-being (Coyne & Downey, 1991; Grant et al., 2006; Monroe & Simons, 1991; Zuckerman, 1999). Empirical findings support a host of personal characteristics that buffer the effects of stressors on maladaptive emotion and behavior (Burns & Machin, 2013; Grover et al., 2009). More to the point of the current study, the

diathesis stress model has been supported with respect to personal attributes involving emotion self-regulation including EC, vagal tone and cognitive reappraisal (Lengua, Bush, Long, Kovacs, & Trancik, 2008; Troy, Wilhelm, Shallcross & Mauss, 2010)—the aspects of ER we are investigating.

Executive function (EF) also should be considered, because EF and ER are widely regarded as cognitive and emotional aspects, respectively, of self-regulation capacity (Calkins & Marcovitch, 2010). EF reflects inter-related cognitive mechanisms (specifically executive attention, inhibitory control, and working memory) that serve self-regulation across a wide variety of cognitive, emotional, and behavioral responses to experiences (Miyake & Friedman, 2012). When an individual becomes physiologically and emotionally aroused by changes in the environment, she or he must effortfully attend to and utilize multiple pieces of information in order to effectively regulate thoughts, feelings, and behaviors in order to maintain homeostasis and behavior appropriately (Bell & Deater-Deckard, 2007; Lemerise & Arsenio, 2000; Ochsner & Gross, 2008). EF is not the same thing as ER; it is involved in a broad range of regulatory functions well beyond just emotion. However, because EF represents the effortful cognitive regulation substrates of ER, we wanted to statistically control for individual differences in EF to see if the hypothesized effects were actually attributable to ER capacity beyond any effects due to EF—to our knowledge, the first time this has been done in a multi-faceted ER model.

Based on the literature, our first hypothesis was that higher levels of chronic family stress and poor ER would be associated with more negative affectivity and less positive affectivity. Our second hypothesis was that emotion regulation would statistically moderate the connection between more stressors and more negative affect and less positive affect, even after controlling for EF. Specifically, we expected women with poorer emotion regulation capacity to show the strongest link between more stress and more negative affectivity, and more stress and less positive affectivity.

Methods

Sample

The sample included 151 mothers (age, $M = 32.79$ yrs, $SD = 6.39$ yrs) and their 3-7 year old children (age, $M = 57.33$ mos, $SD = 15.56$ mos; 50% female) with data on the composite scores we used. The sample was diverse, with a demographic distribution that resembled the region: for mother/father, 75/70% Caucasian, 13/20% African American, 2/2% Asian, 6/5% multiple races, and 5/5% other; 4/2% Hispanic. About one-third were single parents. Education level was widely distributed: for mother/father, 23/33% had a high school diploma/GED or less, and 20/20% had some kind of a post-graduate degree. More details are provided in Measures.

Procedures

Two-thirds of the participants were from a small urban area, recruited through community agencies and advertisements (e.g., flyers in schools and common areas, university website, email). Interested individuals contacted us and were provided with a description of the

study. If the mother was eligible (based on the age of the child being between 3-7 years), she completed informed consent by telephone and then participated at our laboratory in the small city. The other third of the sample was in a cohort of families from an ongoing longitudinal community study, who participated in a visit to our rural university laboratory.

Signed consent and child assent were obtained at the beginning of the visit. Mothers completed questionnaires prior to the visit. At the beginning of the visit, mother and child sat at a table and were recorded during three tasks (four to five minutes each) including drawing with an Etch-A-Sketch drawing toy, doing a puzzle, and building a model using Duplo blocks. For the Etch-A-Sketch drawing task, the parent and child each was assigned a control knob and told not to touch each other's knob, while they worked together to copy one simple line drawing of a square and then one complex line drawing of a smiling face. For the puzzle task, they were asked to put together a puzzle of animal pictures. For the Duplo blocks, the mother was asked to show the child a model castle and then to verbally instruct the child how to copy it. During the task, mothers were not allowed to point to or touch the Duplo blocks. Participating families received an honorarium.

Measures

Stressors—Mothers reported on eight stressors in the questionnaires. We used a cumulative risk approach to scaling, in which the variance in each stressor is summed or averaged—not to represent a single causal factor, but to capture the total cumulative variance representing the overall number and degree of the stressors in a way that does not arbitrarily discard variance in scores (Deater-Deckard, Dodge, Bates, & Pettit, 1998). The eight stressors included: biological father unemployment (0 = employed; 1 = unemployed, 18%), single mother (0 = with partner; 1 = single, 37%), less biological father education (1 = doctorate or professional degree, 19%; 2 = masters degree, 12%; 3 = college graduate 4-year degree, 19%; 4 = some college or 2-year degree, 30%; 5 = high school diploma, 17%; 6 = some high school, 10%; 7 = grade school, 2%), less mother education (1 = doctorate or professional degree, 3%; 2 = masters degree, 16%; 3 = college graduate 4-year degree, 32%; 4 = some college or 2-year degree, 29%; 5 = high school diploma, 13%; 6 = some high school, 7%; 7 = grade school, 0%), number of children in the home ($M = 2.25$, $SD = 1.15$), higher household chaos ($M = 2.25$, $SD = 0.66$), higher child SDQ Total score ($M = 9.49$, $SD = 5.17$), and presence of a child developmental or other disability (0 = none reported; 1 = reported, 13%). Fifty-six mothers (37%) were single parents. Of those, 49 reported full demographic and risk factor information about the child's biological father; seven of the single mothers did not do so, and so data were missing on two indicators regarding the child's biological father (unemployment and education level) in those seven families which potentially produced an underrepresentation of overall risk level in those few cases. That caveat aside, each stressor was standardized, and these were averaged and standardized again to yield a single composite z-score representing the overall number and degree of stressors present.

Emotion Regulation (ER)—ER capacity was assessed using three common constructs in the literature: EC, cognitive reappraisal of emotion, and resting vagal tone. For EC, mothers completed the Adult Temperament Questionnaire (Evans & Rothbart, 2007), which includes

subscales representing inhibitory control, attentional control, and activation control ($a = .68$), $M = 4.57$, $SD = 0.75$. For reappraisal, mothers completed the Emotion Regulation Questionnaire (Gross & John, 2003), which includes a reappraisal subscale ($a = .81$) pertaining to the participants' tendency to evaluate and adjust their interpretations of events and emotional experiences in order to regulate their emotions. The items are rated on a 7-point Likert-type scale (1 = strongly disagree to 7 = strongly agree); $M = 4.99$, $SD = 1.02$.

Vagal tone was measured as resting high-frequency heart rate variability or respiratory sinus arythmia (RSA). With a research assistant's assistance, mothers were instructed to apply two disposable ECG electrodes using modified lead II alignment (right collarbone and lower left rib cage; Stern, Ray, & Guigley, 2001), grounded at the scalp near electrode site Fz. The cardiac electrical activity was amplified using a SA Instrumentation Bioamp (San Diego, CA) and bandpassed from 0.1 to 100 Hz. The QRS complex was displayed on the acquisition computer monitor and digitized at 512 samples per second. The acquisition software was Snapshot-Snapstream (HEM Data Corp.; Southfield, MI) and the raw data were stored for later R-wave detection and RSA analyses. Baseline ECG was recorded for 2 minutes (one minute eyes opened and one minute eyes closed) while mothers were asked to clear their thoughts, sit quietly in a chair, and relax.

ECG data were then examined and analyzed using IBI Analysis System software developed by James Long Company (Caroga Lake, NY). First, R waves were detected offline with a four-pass peak detection algorithm, resulting in a data file with onset times for each detected R-wave. Next, the ECG signal was viewed on a computer monitor along with tick marks representing the onset times of the IBI software detected R-waves. For undetected visible and obscured R-waves, the tick marks were inserted manually. Movement artifact was designated by the absence of at least three consecutive R-waves. These artifact-scored epochs were eliminated from all calculations. The edited R-wave was converted to heart period (i.e., time between hear beats). Spectral analysis was then used to calculate high frequency variability (i.e., RSA) in the heart period data, using a discrete Fourier transform with a 16-second Hanning window and 50% overlap. The frequency band for quantification of RSA was .12-.40 Hz (Berntson, Quigley, & Lozano, 2007). The RSA data were transformed using natural log to normalize the distribution. Baseline RSA was computed by averaging RSA during eyes-open baseline and RSA during eyes-closed baseline (correlation between RSA during two baseline periods: $r = .87$, $p < .001$).

As anticipated (thus, we used one-tailed p-values), the three indicators of ER capacity (i.e., EC, reappraisal, and vagal tone) all positively covaried with each other, with correlations ranging from .12, n.s., to .28, one-tailed $p < .001$. We used scatterplots for visual inspection for potential bivariate outliers, because such outliers tend to powerfully deflate zero-order correlations. We identified five bivariate outliers; with those removed temporarily for composite measure testing, the correlations ranged from .16, one-tailed $p < .04$, to .31, one-tailed $p < .001$. To test the measurement model of a single general construct comprised of these three indicators, we conducted confirmatory factor analysis (CFA) with the five outliers removed. The model fit perfectly because it was saturated. The standardized factor loadings ranged from .34 [95% CI's from .10 to .59] to .62 [95% CI's from .27 to .98]. Each

indicator was standardized, averaged, and standardized again to yield a composite z-score representing overall ER capacity. The composite was normally distributed.

Executive Function (EF)—We counterbalanced four tasks to measure executive attention, inhibition, and memory that comprise a single underlying factor (Miyake & Friedman, 2012). Performance distributions were typical for young-to-middle-age adults (see Deater-Deckard, Wang, Chen, & Bell, 2012).

The Stroop color-word task was administered on a computer (Stroop, 1935). Participants indicated the color of the ink of color words in which the actual color of the letters and the color being named are congruent (e.g., "red" written in red ink) or incongruent (e.g., "red" written in yellow ink), following an initial trial in which the participant simply reported the color of the ink of a series of Xs. We used a set of 20 words with mixed incongruent and congruent stimuli (which minimizes practice effects), and mothers' scores on the task were calculated as the number of correct responses out of 20.

A computerized version of the Wisconsin Card Sorting Test (WCST) involved presentation of four stimulus cards with different colors, quantities, and shapes (Heaton & PAR Staff, 2003). Mothers attempted to match a stack of 64 (at the rural university lab) or 128 (at the urban lab) cards to the original stimulus cards according to a rule which they had to ascertain (i.e., either by color, quantity or shape). The matching rule changed several times and the participant had to infer the new rule based on feedback from the computer regarding correct vs. incorrect responses. We used the number of perseveration errors per 64 trials which represents mistakes made by continuously using the same incorrect matching rule (i.e., difficulty inhibiting the dominant practiced response) even after receiving feedback indicating that the rule was no longer correct.

A computerized version of the Tower of Hanoi was used to measure mothers' problem solving abilities (Davis & Keller, 1998). The task involved moving three disks of different sizes to a target peg in the same order, using two rules: only one disk can be moved each turn, and larger disks cannot be placed on smaller disks. Time to completion (up to 60 secs) was used as the score for the task; those who did not finish received a score of 60 secs.

An experimenter also administered a backward digit span task. The experimenter read a seemingly random series of single-digit numbers (0-9) and the participant attempted to reproduce the sequence in reverse. Following a practice trial with two sets of two digits, the task began with a four digit sequence and then added one more digit in each subsequent trial. Mothers had two chances to correctly reproduce the new digit sequence in reverse. The task ended when the mother provided incorrect responses on both chances. The last correct trial was used as the mother's backward digit span score.

The four indicators positively covaried, with correlations ranging from .19, one-tailed $p <$ .05, to .38, $p < .001$. There was no evidence of bivariate outliers based on visual inspection of scatterplots. We conducted CFA to test for a general EF construct, and model fit was acceptable: X^2 (2) = 3.43, $p = .18$, CFI = .97, RMSEA = .07. Standardized factor loadings ranged from .40 [95% CI's from .20 to .60] to .63 [95% CIs from .44 to .83]. All four scores

were standardized and averaged for every mother who had at least one task score. The average score was standardized again to yield a composite z-score that was widely and normally distributed.

Negative Affectivity—We assessed negative affectivity using three indicators: observed negativity with child, self-reported negativity in relationship with child, and self-reported dispositional negative affectivity. For observers' ratings, trained coders used the PARCHISY global ratings system (Deater-Deckard, 2000) to rate mothers' behavior during the three structured tasks with the child, using the instrument's 7-point Likert-type scales (1 = no occurrence of the behavior, to 7 = continual occurrence of the behavior). During training, two raters rated the sample video independently, then their scores were compared. For items with a rater difference score > 1 on the 7-point scale, the two raters would discuss the item and resolve the discrepancy. For actual data collection, every mother-child dyad was rated using consensus coding, whereby two coders watched and rated the interaction independently, then discussed their scores and resolved any discrepancies. Scores were averaged across the three tasks.

We randomly selected 20% of families for reliability coding; these interactions were coded by all of the raters. Discrepancies of 1 point or less on the 7-point scale were treated as agreements, to mimic what we had done in the derivation of the consensus-based ratings used to compute the actual scores. Individual ratings were treated as items and used to calculate the reliability for each item across raters, based on their original ratings (i.e., pre-consensus scoring) to avoid artificially inflating reliability estimates. We applied generalizability theory by estimating coefficient alpha for each rating scale (i.e., covariance between raters while accounting for within-rater variance; Bakeman & Gottman, 1986, pp. 92-96). Inter-rater reliability was substantial for all scales that we used in the current study ($a > .85$).

We used two items from the PARCHISY to represent maternal negativity: negative affect and conflict with child, $r = .44$, $p < .001$. Both were skewed, so they were log transformed and averaged to yield an overall negative affect score, $M = 0.33$, $SD = 0.06$.

For self-reported negative affect, we used two scales. Women reported on the level of negative affect in their relationship with their child using the negativity scale from the Parent Feelings Questionnaire (Deater-Deckard, 2000), a 31-item questionnaire rated on a 5-point Likert-type scale (1 = definitely untrue to 5 = definitely true), that assesses parents' perceptions of their negative and positive feelings about their child. The negativity scale ($a = .90$) includes items such as, "Sometimes I am not happy about my relationship with this child", $M = 2.48$, $SD = 0.88$. The participants also completed the Adult Temperament Questionnaire Short Form or ATQ-SF (Evans & Rothbart, 2007), a 77-item questionnaire that is completed using a 7-point Likert-type scale (1 = extremely untrue to 7 = extremely true). The Negative Affect scale includes fear, frustration/anger, sadness, and discomfort ($a = .61$), $M = 4.07$, $SD = 0.66$.

We computed a composite score representing overall dispositional negative affectivity across these three indicators. The three indicators positively covaried, with correlations

ranging from .10, n.s., to .31, one-tailed $p < .001$. As with the other constructs, we examined the data for bivariate outliers and identified two participants. With that pair removed temporarily, the correlations were .16, one-tailed $p < .05$, to .31, one-tailed $p < .001$. We again conducted CFA with outliers removed, to test for a general negative affectivity construct. The model fit was perfect because it was saturated. Standardized loadings ranged from .39 [95% CI's from .16 to .62] to .64 [95% CI's from .32 to .97]. The three indicators were standardized and averaged for every mother who had at least one indicator. The average score was standardized again to yield a composite z-score that was widely and normally distributed.

Positive Affectivity—We used two items from the PARCHISY to represent maternal positivity: maternal positive affect and dyadic "reciprocity" (i.e., eye contact and shared positive affect) with child, $r = .69$, $p < .001$. Both were skewed, so they were log transformed and averaged to yield an overall positive affect score, $M = 0.47$, $SD = 0.08$. For self-reported positive affect, we used two scales. Women reported on the level of positive affect in their relationship with their child using the positivity scale from the Parent Feelings Questionnaire described above (Deater-Deckard, 2000). The positivity scale ($a = .83$) includes items such as, "When I think about this child, it usually gives me warm feelings"; $M = 4.72$, $SD = 0.38$. The participants also completed the Adult Temperament Questionnaire (Evans & Rothbart, 2007); for the current construct, we used the Positive Affect subscale that captures dispositional positive emotionality ($a = .65$), $M = 4.82$, $SD = 1.04$.

We computed a composite score representing overall dispositional positive affectivity across these three indicators. As expected, the three indicators positively covaried, with correlations ranging from .09, n.s., to .25, one-tailed $p < .01$. We identified six bivariate outliers that when removed temporarily resulted in correlations from .17, one-tailed $p < .05$, to .30, $p < .001$. We again conducted CFA with outliers temporarily removed, to test for a general negative affectivity construct. The model fit was perfect because it was saturated. Standardized loadings ranged from .36 [95% CI's from .12 to .59] to .61 [95% CI's from .28 to .93]. The three indicators were standardized and averaged for every mother who had at least one indicator. The average score was standardized again to yield a composite z-score that was widely and normally distributed.

Results

The first hypothesis was that higher levels of chronic family stress and poor ER would be associated with more negative affectivity and less positive affectivity (i.e., 10 significant directional correlations). We tested this hypothesis by computing bivariate correlations, shown in Table 1. Those with more stressors were younger, had lower emotion self-regulation and EF scores, higher negative affectivity and lower positive affectivity. Higher emotion self-regulation was associated with lower negative affectivity and higher positive affectivity, and higher EF also was associated with higher positive affectivity. Higher negative affectivity was associated with lower positive affectivity. Overall, there was support for the hypothesized associations, with eight of the ten anticipated correlations significant and in the expected direction. Two expected correlations were not significant, both pertaining to EF (i.e., there were no significant correlations for EF with ER or negative

affectivity). Note that these all well as the subsequent analyses were conducted again with bivariate outliers removed (see Measures section); the results did not change, so findings for the entire sample are reported.

The second hypothesis was that women with poorer ER capacity, even after controlling for EF, would show the strongest links between more stressors, more negative affectivity, and less positive affectivity. That is, we expected ER to emerge as a statistical moderator of the well-established link between stress and emotionality even while also considering additive and interactive effects of EF. To test this hypothesis, we estimated separate regression equations for Negative Affectivity (NA) and Positive Affectivity (PA) as

$$Y = \beta_0 + \beta_{EF} + \beta_{ER} + \beta_{ST} + \beta_{ERxST} + \beta_{EFxST}$$

Standardized regression coefficients for each equation are shown in Table 2. Both equations were statistically significant. For NA, $F(5, 145) = 5.67$, $p < .001$, $R^2 = .16$. For PA, $F(5, 145) = 8.68$, $p < .001$, $R^2 = .23$. Greater NA was statistically predicted by lower ER and the interaction between ER and ST, and greater PA was statistically predicted by higher EF, ER, and lower ST but not by any higher-order interaction terms.

To interpret the two-way interaction for NA, we used analysis of simple slopes at one standard deviation above and below the mean for ER, representing the statistical prediction of mother's negative affectivity by stress. EF was included as a covariate. Results are shown in Table 3, and were consistent with our hypothesis. Table 3 also includes a 1.5 SD and 2.0 SD below the ER mean analysis, in order to examine the pattern at more extreme levels of low ER. Finally, we identified the regions of significance where the simple slope above and below the center of the distribution of the ER moderator would be significantly different from 0. The lower bound was –0.12 and the upper bound was 39.81 (essentially positive infinity given that the highest value on the ER score was 2.13). Thus, the positive slope between more stressors and more NA was significant for those with ER scores < –0.12. Overall, we found the anticipated positive association between having more stressors and greater negative affectivity for women with lower ER, and this effect was strongest at the lowest levels of ER.

Discussion

Personal attributes play a key role in modulating the link between stressors and maladaptive functioning (Monroe & Simons, 1991; Zuckerman, 1999). In the current study, we tested models of stress and emotion self-regulation (ER) in the statistical prediction of variance in women's negative and positive affectivity. By adopting a multi-method, multi-informant approach, we tested a composite as a comprehensive indicator of individual differences in ER spanning aspects of temperament, cognitive reappraisal, and physiology, while also examining potential effects of a composite measure of executive function (EF). There was strong support for the first hypothesis that higher levels of chronic family stress and poor ER would be associated with more negative affectivity and less positive affectivity. This extends to socioeconomic and caregiver stressors the findings from prior research regarding life

events and daily hassles stressors (Hammen, 2005; Lazarus, 2006; Rocke et al., 2009; Stawski et al., 2008).

Yet we anticipated that such effects are not merely additive. Specifically, the diathesis-stress model implicates ER as a *moderator* of the link between more stressors and greater negative/lower positive affectivity (Grant et al., 2006; Monroe & Simons, 1991; Zuckerman, 1999). Thus, our second hypothesis was that women with poorer ER capacity would show the strongest link between more stress and more negative affectivity, as well as less positive affectivity—even when controlling for individual differences in EF, a potentially important aspect of cognitive regulation of emotion. This hypothesis was supported for negative affect but not positive affect—perhaps because positive affectivity is itself ameliorative in the face of stressors, and less effortful to regulate compared to negative emotionality (Aspinwall, 1998; Tice, Baumeister, Shmueli, & Muraven, 2007).

Integrated ER processes are critical to connecting effects of chronic stressors and negative emotionality that reflect diathesis-stress mechanisms (Monroe & Simons, 1991; Zuckerman, 1999) above and beyond any potential effects of deficits in cognitive self-regulation (i.e., EF). With regard to cognitive reappraisal, the diathesis for negative emotionality involves low utilization of thoughts and behaviors that reframe the negative affective state in ways that neutralize it. This reframing process is effortful, yet when successful (as was the case in the current study for those high on reappraisal) it breaks the link between exposure to stressors and chronic negative emotionality (Bryant, Moulds, & Guthrie, 2001; Moore, Zoellner, & Mollenholt, 2008). For effortful control (EC), the diathesis involves the combination of difficulty with regulating attention, inhibiting impulses, and taking action when avoidance is preferred. EC is the temperament foundation of trait conscientiousness (Rothbart et al., 2000), which buffers individuals from stress via reliance on problem-focused coping and low levels of avoidance (Bartley & Roesch, 2011; O'Connor & O'Connor, 2004). Stress-buffering effects of high EC have been found for children and adults alike (Atzaba-Poria, Deater-Deckard, & Bell, 2014; Lengua et al., 2008). Finally, for vagal tone, the diathesis involves rigidity in stress reactivity and sympathetic regulation of arousal through the autonomic nervous system (Porges, 2003). In children and adults, stress buffering effects of vagal tone operate through enhanced attention regulation, access of situationally appropriate emotional responses, and more flexible use of cognitive coping strategies (Calkins, 1997; Fabes & Eisenberg, 1997; Gyurakm & Ayduk, 2008).

Our proposed conceptualization of ER spans several overlapping cognitive, affective and physiological components that help women cope with chronic family and caregiving stressors. ER and its stress buffering effects on negative affectivity operate as part of a broader system of psychological and physiological self-regulation that is not captured by any single component. From a measurement perspective, not only are such composite measures of inter-related sub-components more internally consistent and reliable, they also produce variables that have stronger predictive validity (Rushton, Brainerd, & Pressley, 1983). For this reason, we would encourage theoretical development and empirical work regarding ER's multiple components that test a "unity-diversity" hierarchical structure, akin to the consolidated hierarchical model that has emerged for EF (Miyake & Friedman, 2012). According to a unity-diversity framework, there is parsimony in considering the broadest

single composite level of variation in emotion self-regulation capacities, as we have done in the current study. At this general "unity" level of analysis and construct operationalization, strong ER is best understood as the consolidation of effective cognitive reappraisal of emotional states, physiological regulation of cardiovascular arousal, and temperament-based components of regulated attention, response inhibition and response activation (i.e., effortful control). Such unification of overlapping variance addresses conceptual overlap as well: EC involves those aspects of temperament that best support utilization of cognitive reappraisal, both of which also are supported by strong parasympathetic regulation of arousal (i.e., vagal tone). At the same time, there is "diversity" in the sub-components: variance specific to each that captures distinct features of ER not represented by the other sub-components. Accordingly, no single aspect of ER adequately captures (conceptually or empirically) what is happening in the regulation process. The current results reinforce the utility of a "unity-diversity" framework, given that the moderating effect was very consistent for the composite ER score, while also being reflected in each of the three sub-components we studied.

Caveats and Conclusions

Several limitations should be noted. First, we used a cross-sectional correlational design, which means we could not infer causality or temporal patterns. Chronic family stress and poorer ER are not necessarily the ultimate causes of women's negative emotionality. Alternative explanations exist for these associations; clarification of the mechanisms requires quasi-experimental and true experimental designs. Second, we relied heavily on self-reports for information about stressors, ER, and affectivity. Although the inclusion of physiological and observational methods diminishes concerns about biased results, most of the indicators were based on women's own perceptions. Third, our measurement of chronic stressors did not assess construal of those stressors, including whether the women believed the stressors influenced them and if so, the magnitude of these effects on personal and family functioning. Fourth, our sample only included women who had children, so may not generalize to women who are not mothers, and may not generalize to men. A stronger design would incorporate a representative sample of women and men and consider a wider variety of role and contextual stressors.

These limitations aside, several conclusions can be drawn. First, ER and contextual stressors both should be considered when testing hypotheses regarding individual differences in women's dispositional affect. The role of stressors as potential ongoing causal factors in chronic negative emotionality—a major component of psychopathology—may be inadvertently underestimated in research that does not distinguish between poorly and well regulated individuals. Similarly, lack of consideration of regulatory factors overlooks malleable factors that can be better leveraged in improved prevention and intervention efforts. Second, the findings provide further evidence that ER is a process involving several inter-related mechanisms or domains. There was congruence in the physiological, cognitive and temperament aspects of ER in the current study. To our knowledge, this is the first study to test composite and individual sub-component variables for ER that spanned physiological, cognitive and temperament domains. This approach provides a more thorough picture of an integrated ER process, and may be a model for measurement of ER in future research.

Third, given its importance in emotionality and risk for psychopathology, ER is a critical target for effective intervention, especially for women facing chronic stressors. Recent experimental evidence is challenging widely held notions that regulatory aspects of temperament, cognition and physiology are "fixed traits". These sub-domains of ER are connected, and can be improved directly through practice as demonstrated in effective mindfulness, integrative body-mind, and cognitive behavioral training interventions (Baer, 2003; Tang et al., 2007).

Acknowledgement

References

Aspinwall L. Rethinking the role of positive affect in self-regulation. Motivation and Emotion. 1998; 22:1–32.

Baer RA. Mindfulness training as a clinical intervention: A conceptual and empirical review. Clinical Psychology: Science and Practice. 2003; 10:125–143.

Bakeman, R.; Gottman, JM. Observing interaction: An introduction to sequential analysis. Cambridge University Press; Cambridge, UK: 1986.

Bartley C, Roesch S. Coping with daily stress: The role of conscientiousness. Personality and Individual Differences. 2011; 50:79–83. [PubMed: 21076634]

Bell MA, Deater-Deckard K. Biological systems and the development of self-regulation: Integrating behavior, genetics, and psychophysiology. Journal of Developmental & Behavioral Pediatrics. 2007; 28(5):409–420. [PubMed: 18049327]

Berntson GG, Cacioppo JT, Quigley KS. Cardiac psychophysiology and autonomic space in humans: Empirical perspectives and conceptual implications. Psychological Bulletin. 1993; 114:296–322. [PubMed: 8416034]

Berntson, GG.; Quigley, KS.; Lozano, D. Cardiovascular psychophysiology. In: Cacioppo, JT.; Tassinary, LG.; Berntson, G., editors. Handbook of psychophysiology. 3rd. Cambridge University Press; New York: 2007. p. 182-210.

Bryant RA, Moulds M, Guthrie RM. Cognitive strategies and the resolution of acute stress disorder. Journal of Traumatic Stress. 2001; 14(1):213–219.

Burns RA, Machin MA. Psychological wellbeing and the diathesis-stress hypothesis model: The role of psychological functioning and quality of relations in promoting subjective well-being in a life events study. Personality and Individual Differences. 2013; 54(3):321–326.

Calkins SD. Cardiac vagal tone indices of temperamental reactivity and behavioral regulation in young children. Developmental Psychobiology. 1997; 31:125–135. [PubMed: 9298638]

Calkins, SD.; Marcovitch, S. Emotion regulation and executive functioning in early development: Mechanisms of control supporting adaptive functioning. In: Calkins, S.; Bell, MA., editors. Child development at the intersection of emotion and cognition. American Psychological Association; Washington, DC: 2010.

Collins DL, Baum A, Singer JE. Coping with chronic stress at Three Mile Island: Psychological and biochemical evidence. Health Psychology. 1983; 2:149–166.

Conger RD, Wallace LE, Sun Y, Simons RL, McLoyd VC, Brody GH. Economic pressure in African American families: a replication and extension of the family stress model. Developmental Psychology. 2002; 38(2):179–193. [PubMed: 11881755]

Coyne JC, Downey G. Social factors and psychopathology: Stress, social support, and coping processes. Annual Review of Psychology. 1991; 42(1):401–425.

Davis, HP.; Keller, FR. Colorado assessment test manual. Colorado Assessment Tests; Colorado Springs: 1998.

Day AL, Livingstone HA. Chronic and acute stressors among military personnel: do coping styles buffer their negative impact on health? Journal of Occupational Health Psychology. 2001; 6:348–360. [PubMed: 11605828]

Deater-Deckard K. Parenting and child behavioral adjustment in early childhood: A quantitative genetic approach to studying family processes and child development. Child Development. 2000; 71:468–484. [PubMed: 10834478]

Deater-Deckard K, Dodge KA, Bates JE, Pettit GS. Multiple risk factors in the development of externalizing behavior problems: Group and individual differences. Development and Psychopathology. 1998; 10(03):469–493. [PubMed: 9741678]

Deater-Deckard K, Wang Z, Chen N, Bell MA. Maternal executive function, harsh parenting, and child conduct problems. Journal of Child Psychology and Psychiatry. 2012; 53:1084–1091. [PubMed: 22764829]

Derryberry D, Rothbart MK. Reactive and effortful processes in the organization of temperament. Development and Psychopathology. 1997; 9:633–652. [PubMed: 9448999]

Dunn, LM.; Dunn, DM. PPVT-4 Manual. NCS Pearson; Bloomington, MN: 2007.

Engle, RW.; Kane, MJ. Executive attention, working memory capacity, and a two-factor theory of cognitive control. In: Ross, B., editor. The psychology of learning and motivation. Academic Press; New York: 2004. p. 145-199.

Evans DE, Rothbart MK. Developing a model for adult temperament. Journal of Research in Personality. 2007; 41:868–888.

Evans, GW.; Wachs, T., editors. Chaos and its influence on children's development: An ecological perspective. American Psychological Association; Washington, DC: 2009.

Fabes RA, Eisenberg N. Regulatory control and adults' stress-related responses to daily life events. Journal of Personality and Social Psychology. 1997; 73(5):1107–1117. [PubMed: 9364764]

Folkman S, Lazarus RS, Pimley S, Novacek J. Age differences in stress and coping processes. Psychology and Aging. 1987; 2(2):171–184. [PubMed: 3268206]

Grant KE, Compas BE, Thurm AE, McMahon SD, Gipson PY, Campbell AJ, Westerholm RI. Stressors and child and adolescent psychopathology: Evidence of moderating and mediating effects. Clinical Psychology Review. 2006; 26(3):257–283. [PubMed: 16364522]

Gross JJ. The emerging field of emotion regulation: An integrative review. Review of General Psychology. 1998; 2(3):271–299.

Gross JJ, John OP. Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. Journal of Personality and Social Psychology. 2003; 85:348–362. [PubMed: 12916575]

Grover KE, Green KL, Pettit JW, Monteith LL, Garza MJ, Venta A. Problem solving moderates the effects of life event stress and chronic stress on suicidal behaviors in adolescence. Journal of Clinical Psychology. 2009; 65(12):1281–1290. [PubMed: 19827110]

Gyurak A, Ayduk Ö. Resting respiratory sinus arrhythmia buffers against rejection sensitivity via emotion control. Emotion. 2008; 8(4):458–467. [PubMed: 18729578]

Hammen C. Stress and depression. Annual Review of Clinical Psychology. 2005; 1:293–319.

Hammen C, Kim EY, Eberhart NK, Brennan PA. Chronic and acute stress and the prediction of major depression in women. Depression and Anxiety. 2009; 26:718–723. [PubMed: 19496077]

Heaton, RK.; PAR Staff. Wisconsin Card Sorting Test: Computer version 4. Psychological Assessment Resources; Odessa, FL: 2003.

Lazarus, RS. Stress and emotion: A new synthesis. Springer Publishing Company; 2006.

Lazarus RS, DeLongis A. Psychological stress and coping in aging. American Psychologist. 1983; 38(3):245–254. [PubMed: 6870040]

Lemerise EA, Arsenio WF. An integrated model of emotion processes and cognition in social information processing. Child Development. 2000; 71(1):107–118. [PubMed: 10836564]

Lengua LJ, Bush NR, Long AC, Kovacs EA, Trancik AM. Effortful control as a moderator of the relation between contextual risk factors and growth in adjustment problems. Development and Psychopathology. 2008; 20(02):509–528. [PubMed: 18423092]

Matud MP. Gender differences in stress and coping styles. Personality and Individual Differences. 2004; 37(7):1401–1415.

McEwen BS. Stress, adaptation and disease: Allostasis and allostatic load. Annals of the New York Academy of Sciences. 1998; 840:33–44. [PubMed: 9629234]

Miyake A, Friedman NP. The nature and organization of individual differences in executive functions four general conclusions. Current Directions in Psychological Science. 2012; 21(1):8–14. [PubMed: 22773897]

Monroe SM, Simons AD. Diathesis-stress theories in the context of life stress research: Implications for the depressive disorders. Psychological Bulletin. 1991; 110:406–425. [PubMed: 1758917]

Moore SA, Zoellner LA, Mollenholt N. Are expressive suppression and cognitive reappraisal associated with stress-related symptoms? Behaviour Research and Therapy. 2008; 46(9):993–1000. [PubMed: 18687419]

Nezlek JB, Kuppens P. Regulating positive and negative emotions in daily life. Journal of Personality. 2008; 76(3):561–580. [PubMed: 18399953]

O'Connor D, O'Connor R. Perceived changes in food intake in response to stress: the role of conscientiousness. Stress and Health. 2004; 20:279–291.

Ochsner KN, Gross JJ. Cognitive emotion regulation insights from social cognitive and affective neuroscience. Current Directions in Psychological Science. 2008; 17(2):153–158. [PubMed: 25425765]

Oman RF, King AC. The effect of life events and exercise program format on the adoption and maintenance of exercise behavior. Health Psychology. 2000; 19(6):605–612. [PubMed: 11129364]

Porges SW. Orienting in a defensive world: Mammalian modifications of our evolutionary heritage. A Polyvagal Theory. Psychophysiology. 1995; 32:301–318. [PubMed: 7652107]

Porges SW, Doussard-Roosevelt JA, Maiti AK. Vagal tone and the physiological regulation of emotion. Monographs of the Society for Research in Child Development. 1994; 59(2-3):167–186. [PubMed: 7984159]

Porges SW. The Polyvagal Theory: Phylogenetic contributions to social behavior. Physiology and Behavior. 2003; 79:503–513. [PubMed: 12954445]

Richards JM, Gross JJ. Emotion regulation and memory: the cognitive costs of keeping one's cool. Journal of Personality and Social Psychology. 2000; 79(3):410–424. [PubMed: 10981843]

Röcke C, Li SC, Smith J. Intraindividual variability in positive and negative affect over 45 days: do older adults fluctuate less than young adults? Psychology and Aging. 2009; 24:863–878. [PubMed: 20025402]

Rothbart MK, Ahadi SA, Evans DE. Temperament and Personality: Origins and outcomes. Personality and Social Psychology. 2000; 78:122–135.

Rothbart, MK.; Bates, JE. Temperament. In: Eisenberg, N., editor. Handbook of child psychology: Vol. 3. Social, emotional, and personality development. 5th. Wiley; New York: 1998. p. 105-176.

Rushton JP, Brainerd CJ, Pressley M. Behavioral development and construct validity: The principle of aggregation. Psychological Bulletin. 1983; 94:18–38.

Selye, H. The stress of life. McGraw-Hill; New York: 1956.

Stawski RS, Sliwinski MJ, Almeida DM, Smyth JM. Reported exposure and emotional reactivity to daily stressors: the roles of adult age and global perceived stress. Psychology and Aging. 2008; 23:52–61. [PubMed: 18361654]

Stern, RM.; Ray, WJ.; Quigley, KS. Psychophysiological recording. Oxford University Press; 2001.

Stroop JR. Studies of interference in serial verbal reactions. Journal of Experimental Psychology. 1935; 18(6):643–662.

Tang YY, Ma Y, Wang J, Fan Y, Feng S, Lu Q, Posner MI. Short-term meditation training improves attention and self-regulation. Proceedings of the National Academy of Sciences. 2007; 104(43): 17152–17156.

Tice D, Baumeister R, Shmueli D, Muraven M. Restoring the self: Positive affect helps improve self-regulation following ego depletion. Journal of Experimental Social Psychology. 2007; 43:379–384.

Troy AS, Wilhelm FH, Shallcross AJ, Mauss IB. Seeing the silver lining: cognitive reappraisal ability moderates the relationship between stress and depressive symptoms. Emotion. 2010; 10(6):783–795. [PubMed: 21058843]

van Eck M, Nicolson NA, Berkhof J. Effects of stressful daily events on mood states: relationship to global perceived stress. Journal of Personality and Social Psychology. 1998; 75(6):1572–1585. [PubMed: 9914667]

Zuckerman, M. Vulnerability to psychopathology: A biosocial model. American Psychological Association; Washington, DC: 1999. p. 3-23.

Table 1

Bivariate Correlations

Maternal age	1					
Stressors	−.34***	1				
Emotion Reg	−.03	−.36***	1			
Exec Function	.20*	−.23**	.12	1		
Negative Affectivity	.09	.28***	−.32***	−.06	1	
Positive Affectivity	.14+	−.39***	.29***	.33***	−.41***	1

+
$p < .10$

*
$p < .05$

**
$p < .01$

***
$p < .001$

Table 2

Standardized Coefficients for Hierarchical regression modeling Predicting Mother's Negative and Positive Affectivity

	NA	PA
EF	.03	.24[**]
Stressors	.13[**]	−.28[***]
ER	−.22	.17[*]
EF × Stressors	−.05	.01
ER × Stressors	−.17[*]	−.03

Note EF= Executive Function; ER= Emotion Regulation; NA= Negative Affectivity; PA= Positive Affectivity.

[*]
p < .05

[**]
p < .01

[***]
p < .001

Table 3

Post-Hoc Simple Slopes Representing Prediction of Negative Affectivity from Stressors: Above (+) or Below (−) Mean (M) for Emotion Regulation (ER)

	Above ER M	Below ER M		
	+1.0 SD	−1.0 SD	−1.5 SD	−2.0 SD
ER variable:				
Composite	.01	.28**	.34**	.41**
Reappraisal	.10	.39**	.46**	.54**
Vagal Tone	.10	.38**	.45**	.52**
Effortful Control	.01	.19*	.23*	.27*

*
$p < .05$

**
$p < .01$