Multifaceted emotion regulation, stress and affect in mothers of young children

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We tested a novel multi-component emotion self-regulation construct that captured physiological (vagal tone), cognitive (reappraisal) and temperament (effortful control) aspects of emotion regulation (ER) as a moderator of the link between more stressors and greater negative/less positive affectivity (NA and PA). A socio-economically 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 NA and less PA. Furthermore, for NA only, having more stressors was substantially associated with NA 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: Emotion regulation; Stress; Affect; Executive function.

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 operationalised using physiology (i.e., vagal tone), cognition (i.e., reappraisal of situations and emotions) and temperament [i.e., effortful control (EC)], but these are rarely 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 socio-economic and caregiving role stressors.

Stress and emotionality

In the current study, we used a stress homeostasis framework to conceptualise the roles of chronic stressors, emotionality and ER that are brought to bear to maintain biological and psychological functioning while minimising psychological and physiological costs to the individual (Lazarus, 2006; Selye, 1956). According to this framework,
negative affectivity (NA) arises to motivate change in behaviour when homeostasis is threatened by potential punishments or losses of rewards in the environment. “Stressors” (ST) 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 emphasised 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 socio-economic 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 also may operate via reduced positive affectivity (PA). Frequent daily hassles and chronic health problems are associated with transient and stable positive affect (Röcke, 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 both PA and NA.

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 socio-economic/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 behavioural problems; Folkman, Lazarus, Pimley, & Novacek, 1987). Family economic hardship, household and neighbourhood “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 NA and low PA (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 (Matud, 2004; Oman & King, 2000). 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 behavioural 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 interrelated components of emotions, thoughts, behaviours and physiology that are integrated to account for stable individual differences in regulatory capacity. A broad view is useful because ER has been operationalised 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., EC; 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 interrelated 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: EC (self-reported); vagal tone (ECG recording); and
reappraisal of emotionally salient experiences (self-reported).

EC, the first component of ER we consider, is a temperament factor comprised of facets of self-regulation of emotions, thoughts and behaviours (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 organised and socially appropriate behaviour (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 neutralising emotional stimuli, cognitive reappraisal helps regulate the impact of internal and external stressors on emotion with concomitant reductions in NA (Gross, 1998; Nezlek & Kuppens, 2008). Experimental and correlational findings indicate reappraisal leading to more effective cognitive, affective and physiological ER (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 behaviour (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 ER 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 interrelated cognitive mechanisms (specifically executive attention, inhibitory control and working memory) that serve self-regulation across a wide variety of cognitive, emotional and behavioural 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 utilise multiple pieces of information in order to effectively regulate thoughts, feelings and behaviours in order to maintain homeostasis and behaviour 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 hypothesised 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 multifaceted 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 NA and less PA. Our second hypothesis was that ER 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 ER
capacity to show the strongest link between more stress and more NA, and more stress and less PA.

METHODS

Sample

The sample included 151 mothers (age, \(M = 32.79\) years, \(SD = 6.39\) years) and their 3- to 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/graduate equivalent diploma or less, and 20/20% had some kind of a postgraduate 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 and 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 = master’s 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 = master’s 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 total score on child Strengths and Difficulties Questionnaire (\(M = 9.49, SD = 5.17\)) and presence of a child developmental or other disability (0 = none reported; 1 = reported, 13%). Fifty-six mothers
were single parents. Of those, 49 reported full demographic and risk factor information about the child’s biological father; 7 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 standardised, and these were averaged and standardised again to yield a single composite z-score representing the overall number and degree of stressors present.

**Emotion regulation**

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 ($\alpha = .68$), $M = 4.57$, $SD = 0.75$. For reappraisal, mothers completed the Emotion Regulation Questionnaire (Gross & John, 2003), which includes a reappraisal subscale ($\alpha = .81$) 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 arrhythmia (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, & Quigley, 2001), grounded at the scalp near electrode site Fz. The cardiac electrical activity was amplified using a SA Instrumentation Bioamp (San Diego, CA) and band-passed from 0.1 to 100 Hz. The QRS complex was displayed on the acquisition computer monitor and digitised 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 two 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 analysed 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 artefact was designated by the absence of at least three consecutive R-waves. These artefact-scored epochs were eliminated from all calculations. The edited R-wave was converted to heart period (i.e., time between heart 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 to .40 Hz (Berntson, Quigley, & Lozano, 2007). The RSA data were transformed using natural log to normalise 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, ns, 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 standardised factor loadings ranged from .34 [95% CIs from .10 to .59] to .62 [95% CIs from .27 to .98]. Each indicator was standardised, averaged and standardised again to yield a composite \( z \)-score representing overall ER capacity. The composite was normally distributed.

**Executive function**

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 colour-word task was administered on a computer (Stroop, 1935). Participants indicated the colour of the ink of colour words in which the actual colour of the letters and the colour 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 colour of the ink of a series of Xs. We used a set of 20 words with mixed incongruent and congruent stimuli (which minimises practice effects), and mothers’ scores on the task were calculated as the number of correct responses out of 20.

A computerised version of the Wisconsin Card Sorting Test involved presentation of four stimulus cards with different colours, 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 colour, 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 computerised 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 seconds) was used as the score for the task; those who did not finish received a score of 60 seconds.

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: \( \chi^2(2) = 3.43, p = .18, \) CFI = .97, RMSEA = .07. Standardised factor loadings ranged from .40 [95% CIs from .20 to .60] to .63 [95% CIs from .44 to .83]. All four scores were standardised and averaged for every mother who had at least one task score. The average score was standardised again to yield a composite \( z \)-score that was widely and normally distributed.

**Negative affectivity**

We assessed NA using three indicators: observed negativity with child, self-reported negativity in relationship with child and self-reported dispositional NA. For observers’ ratings, trained coders used the PARCHISY global ratings system.
(Deater-Deckard, 2000) to rate mothers’ behaviour during the three structured tasks with the child, using the instrument’s 7-point Likert-type scales (1 = no occurrence of the behaviour, to 7 = continual occurrence of the behaviour). 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 generalisability theory by estimating coefficient alpha for each rating scale (i.e., covariance between raters while accounting for within-rater variance; Bakerman & Gottman, 1986, pp. 92–96). Inter-rater reliability was substantial for all scales that we used in the current study (α > .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 (α = .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 (α = .61), M = 4.07, SD = 0.66.

We computed a composite score representing overall dispositional NA across these three indicators. The three indicators positively covaried, with correlations ranging from .10, ns, 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 PA construct. The model fit was perfect because it was saturated. Standardised loadings ranged from .39 [95% CIs from .16 to .62] to .64 [95% CIs from .32 to .97]. The three indicators were standardised and averaged for every mother who had at least one indicator. The average score was standardised 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 (α = .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 (\( \alpha = .65 \), \( M = 4.82, SD = 1.04 \)).

We computed a composite score representing overall dispositional PA across these three indicators. As expected, the three indicators positively covaried, with correlations ranging from .09, ns, 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 PA construct. The model fit was perfect because it was saturated. Standardised loadings ranged from .36 [95% CIs from .12 to .59] to .61 [95% CIs from .28 to .93]. The three indicators were standardised and averaged for every mother who had at least one indicator. The average score was standardised 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 NA and less PA (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 ER and EF scores, higher NA and lower PA. Higher ER was associated with lower NA and higher PA, and higher EF also was associated with higher PA. Higher NA was associated with lower PA. Overall, there was support for the hypothesised associations, with 8 of the 10 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 NA). 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 NA and less PA. 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 NA and PA as:

\[
Y = \beta_0 + \beta_{EF} + \beta_{ER} + \beta_{ST} + \beta_{ER \times ST} + \beta_{EF \times ST}
\]

Standardised 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

<table>
<thead>
<tr>
<th>Table 1. Bivariate correlations</th>
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<tbody>
<tr>
<td>Maternal age</td>
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<tr>
<td>Stressors</td>
</tr>
<tr>
<td>Positive affectivity</td>
</tr>
<tr>
<td>Negative affectivity</td>
</tr>
<tr>
<td>Executive function</td>
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<tr>
<td>Emotion regulation</td>
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<tr>
<td>Stressed</td>
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<tr>
<td>Positive affectivity</td>
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<tr>
<td>Stressed</td>
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<tr>
<td>Positive affectivity</td>
</tr>
<tr>
<td>Stressed</td>
</tr>
<tr>
<td>Positive affectivity</td>
</tr>
</tbody>
</table>

\( * p < .10; \* p < .05; \** p < .01; \*** p < .001.\)
Table 2. *Standardised coefficients for hierarchical regression modelling predicting mother’s NA and PA*

<table>
<thead>
<tr>
<th></th>
<th>NA</th>
<th>PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF</td>
<td>.03</td>
<td>.24**</td>
</tr>
<tr>
<td>Stressors</td>
<td>.13**</td>
<td>−.28***</td>
</tr>
<tr>
<td>ER</td>
<td>−.22</td>
<td>.17*</td>
</tr>
<tr>
<td>EF × Stressors</td>
<td>−.05</td>
<td>.01</td>
</tr>
<tr>
<td>ER × Stressors</td>
<td>−.17*</td>
<td>−.03</td>
</tr>
</tbody>
</table>

EF, executive function; ER, emotion regulation; NA, negative affectivity; PA, positive affectivity. *p < .05; **p < .01; ***p < .001.

NA 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 centre of the distribution of the ER moderator would be significantly different from zero. 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 less than −0.12. Overall, we found the anticipated positive association between having more stressors and greater NA for women with lower ER, and this effect was strongest at the lowest levels of ER.

Table 3. *Post-hoc simple slopes representing prediction of NA from stressors: above (+) or below (−) mean (M) for emotion regulation (ER)*

<table>
<thead>
<tr>
<th>ER variable</th>
<th>Above ER M</th>
<th>Below ER M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+1.0 SD</td>
<td>−1.0 SD</td>
</tr>
<tr>
<td>Composite</td>
<td>.01</td>
<td>.29**</td>
</tr>
<tr>
<td>Reappraisal</td>
<td>.10</td>
<td>.39**</td>
</tr>
<tr>
<td>Vagal tone</td>
<td>.10</td>
<td>.38**</td>
</tr>
<tr>
<td>Effortful control</td>
<td>.01</td>
<td>.19*</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01.

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 ER in the statistical prediction of variance in women’s NA and PA. 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 EF. There was strong support for the first hypothesis that higher levels of chronic family stress and poor ER would be associated with more NA and less PA. This extends to socio-economic and caregiver stressors the findings from prior research regarding life events and daily hassles stressors (Hammen, 2005; Lazarus, 2006; Röcke 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 NA/lower PA (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 NA, as well as less PA—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 PA 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 utilisation
of thoughts and behaviours that reframe the negative affective state in ways that neutralise it. This re-framing 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 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 ANS (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; Gyurak & Ayduk, 2008).

Our proposed conceptualisation 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 NA 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 interrelated sub-components more internally consistent and reliable, but 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 ER capacities, as we have done in the current study. At this general “unity” level of analysis and construct operationalisation, 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., EC). Such unification of overlapping variance addresses conceptual overlap as well: EC involves those aspects of temperament that best support utilisation 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 generalise to women who are not mothers, and may not generalise 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 interrelated 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 behavioural training interventions (Baer, 2003; Tang et al., 2007).

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