

## RESEARCH ARTICLE

# Relationships Among Positive Emotions, Coping, Resilience and Mental Health<sup>‡</sup>

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### Abstract

The broaden-and-build theory of positive emotions suggests that positive emotions can widen the range of potential coping strategies that come to mind and subsequently enhance one's resilience against stress. Studies have shown that high stress, especially chronic levels of stress, strongly contributes to the development of anxiety and depressive symptoms. However, researchers have also found that individuals who possess high levels of resilience are protected from stress and thus report lower levels of anxiety and depressive symptoms. Using a sample of 200 postdoctoral research fellows, the present study examined if (a) positive emotions were associated with greater resilience, (b) coping strategies mediated the link between positive emotions and resilience and (c) resilience moderated the influence of stress on trait anxiety and depressive symptoms. Results support the broaden-and-build theory in that positive emotions may enhance resilience directly as well as indirectly through the mediating role of coping strategies—particularly via adaptive coping. Resilience also moderated the association of stress with trait anxiety and depressive symptoms. Although stress is unavoidable and its influences on anxiety and depressive symptoms are undeniable, the likelihood of postdocs developing anxiety or depressive symptoms may be reduced by implementing programmes designed to increase positive emotions, adaptive coping strategies and resilience. Copyright © 2014 John Wiley & Sons, Ltd.

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### Keywords

stress; anxiety; depression; postdoc; mediation; moderation

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## Introduction

Growing research guided by the broaden-and-build theory of positive emotions continues to find evidence in support of the notion that positive emotions have the ability to widen the range of potential coping strategies that come to one's mind during times of stress, consequently enhancing one's resilience against present and future adversity (Folkman & Moskowitz, 2000; Fredrickson, 2004, 2005; Tugade, Fredrickson, & Feldman Barrett, 2004). According to Fredrickson (2001), the experience of positive emotions unlocks the human cognition and encourages individuals to think more freely, thoughtfully and creatively. These effects, in turn, expand one's outlook and capacity to see the world with a broader perspective. As a result, those who experience greater frequencies of positive emotions have an improved ability to recognize a wider range of possible coping strategies when faced with

adversity; thus, they are able to tackle stress more effectively and achieve higher levels of resilience (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Fredrickson, 2009; Gloria, Faulk, & Steinhardt, 2013).

In their theory of stress and coping, Lazarus and Folkman (1984) define stress as a transactional process between the person and the environment, whereby the individual appraises the environmental demands as outweighing his or her ability to meet those demands. During stressful situations, the mind and body instinctively trigger the fight-or-flight response in an effort to diminish threat, harm or loss. This stress response activates an array of physiological and psychological reactions including increased heart rate, blood pressure and respiration. In addition, one's mindset and worldview dramatically narrows and sharply focuses toward the triggering stressor (Kok, Catalino, & Fredrickson, 2008). These evolutionarily adaptive reactions serve critical purposes for survival, particularly during

threatening and stressful situations (Fredrickson, 2001). Although the fight-or-flight response can be beneficial toward acute stressors, long-term and chronic exposure is harmful to health. When individuals are exposed to enduring forms of stress, the physiological and psychological reactions of the fight-or-flight response are likewise sustained over time. This heightened and long-lasting state of stress beyond homeostasis increases one's risks for a number of serious health problems including cardiovascular disease (Iso et al., 2002; Jood, Redfors, Rosengren, Blomstrand, & Jern, 2009), obesity (de Luca & Olefsky, 2006), diabetes (Lloyd, Smith, & Weinger, 2005), immune disease (Kemeny & Schedlowski, 2007), burnout (Lloyd, King, & Chenoweth, 2002), anxiety (Kleppa, Sanne, & Tell, 2008) and depression (Nielsen, Kristensen, Schnohr, & Grønbaek, 2008; Steinhart, Smith Jaggars, Faulk, & Gloria, 2011).

Anxiety and depressive symptoms are particular concerns, considering their strong associations with stress (Newbury-Birch & Kamali, 2001; Rawson, Bloomer, & Kendall, 1994). Studies have shown that high levels of stress significantly contribute to the development of subclinical symptoms of anxiety and depression (Kleppa et al., 2008; Markou & Cryan, 2012; Melchior et al., 2007; Misra & McKean, 2000). Anxiety and depressive symptoms can be debilitating, not only harming the individual experiencing such symptoms but also negatively impacting others. Those who suffer from anxiety and depressive symptoms have increased morbidity and mortality risks (Carney & Freedland, 2003; Mykletun et al., 2007) and are likely to have deteriorating interpersonal relationships (Insel & Roth, 2012). They also have higher rates of absenteeism in tandem with decreased productivity at the workplace (Stewart, Ricci, Chee, Hahn, & Morganstein, 2003).

However, there is evidence showing that individual resilience can moderate the impact of stress on anxiety and depressive symptoms (Aroian & Norris, 2000; Pinguart, 2009; Wagnild, 2003; Wingo et al., 2010). Studies found that stress had a weaker influence toward the health of individuals who possessed higher levels of resilience. Researchers have also demonstrated that positive emotions can improve one's ability to cope with stress (Burns et al., 2008), and improved coping subsequently enhances resilience (Tugade et al., 2004).

Cognitive-behavioural coping strategies focus on identifying and changing the maladaptive thinking and behaviour that create stress in an effort to prevent or diminish threat, harm or loss (Lazarus, 1993; Lazarus & Folkman, 1984). Adaptive coping strategies (e.g. active coping, planning and positive reframing) are actions and behaviours used in response to stress, which lead to improved outcomes. In contrast, maladaptive coping strategies (e.g. denial, venting and substance abuse) often result in undesirable consequences (Brown, Westbrook, & Challagalla, 2005; Carver, 1997; Zeidner & Saklofske, 1996). Although

positive emotions can improve one's ability to cope with stress, to our knowledge, no studies have investigated how positive emotions influence different types of coping strategies—specifically, adaptive and maladaptive. Furthermore, if one's coping strategies mediate the relationship between positive emotions and resilience, such that positive emotions are positively related to adaptive coping strategies and resilience and inversely related to maladaptive coping strategies, it would provide support for the broaden-and-build theory of positive emotions (Fredrickson, 2004, 2005).

Although previous works in this field have studied a variety of highly stressed populations, including college students (Fredrickson, Tugade, Waugh, & Larkin, 2003), public school teachers (Steinhart et al., 2011), doctors (Newbury-Birch & Kamali, 2001) and military spouses (Faulk, Gloria, Steinhart, & Cance, 2012), there is a lack of research toward a particularly high-stressed population—namely postdoctoral research fellows (postdocs). Postdocs, ironically, are an overlooked and understudied population. It has been reported that the work and life conditions of postdocs in the United States are inundated by chronic exposure to high levels of stress (Smaglik, 2006; Small, 2012). Often characterized as neither a faculty member nor a student, postdocs tend to fall in the cracks and consequently receive neither the recognition nor the benefits that they feel are deserved (e.g. control over their work/funding and health insurance for self and family; Aschwanden, 2006; Smaglik, 2006). They also often report feelings of fear, uncertainty, pressure and lack of security due to the impermanence of their employment, high work expectations and extreme competitiveness of the job market (i.e. low supply and high demand for ideal jobs such as tenure-track professors/researchers; Kaplan, 2012; Woolston, 2002). Considering these points, it is not surprising that postdocs describe their work and life as extremely stressful and often filled with feelings of anxiety and depression.

Therefore, using a sample of postdocs, the purpose of the present study was to examine if (a) positive emotions were associated with greater resilience, (b) adaptive and maladaptive coping strategies mediated the link between positive emotions and resilience and (c) resilience moderated the influence of stress on trait anxiety and depressive symptoms (i.e. as levels of stress increase, individuals with higher scores of resilience will report lower levels of trait anxiety or depressive symptoms as compared with those with lower resilience). Importantly, this research aimed to broadly observe and unobtrusively explore the general relationships among positive emotions, coping strategies, resilience, stress and mental health, as these variables occurred and interacted in the natural world and lives of postdoctoral research fellows. Thus, this work did not intend to clinically evaluate or diagnose participants with regard to clinical anxiety and depression; the investigators were instead interested in studying

the participants' self-reported assessments of their own qualities and mental health.

In the mediation analysis, it was hypothesized that (a) positive emotions would have a positive direct effect on adaptive coping strategies, (b) positive emotions would have a negative direct effect on maladaptive coping strategies, (c) positive emotions would have a positive direct effect on resilience, (d) adaptive coping strategies would have a positive direct effect on resilience, (e) maladaptive coping strategies would have a negative direct effect on resilience and (f) adaptive and maladaptive coping strategies would mediate the relationship between positive emotions and resilience. It was also hypothesized that (g) the indirect effect through adaptive coping strategies would be stronger than through maladaptive coping strategies. As for the moderation analysis, it was hypothesized that (a) stress would have a positive direct effect on trait anxiety and depressive symptoms, (b) resilience would have a negative direct effect on trait anxiety and depressive symptoms and (c) resilience would interact with stress in such a manner that resilience would moderate the effect of stress on trait anxiety and depressive symptoms.

## Methods

### Participants and procedures

Participants were recruited from a pool of postdocs who were employed at a large research institution in Texas. The email addresses of potential participants ( $n = 523$ ) were obtained from the institution's human resources office, and recruitment letters were sent via email inviting postdocs to voluntarily participate in a Qualtrics online survey that required approximately 30 min to complete. The sample selection method did not have exclusion criteria, except that participants must be currently employed under a postdoctoral research fellowship appointment during the time of data collection.

In order to enhance the survey response rate, a variety of incentive prizes were offered (Deutskens, de Ruyter, Wetzels, & Oosterveld, 2004). Each participant was compensated with a \$5 Starbucks gift card, a deck of inspirational quote cards (\$2 value) and an *Individual Feedback Profile* document that provided a confidential report of the participant's results as well as an anonymous summary of the sample's aggregate results. In addition, participants were entered into a lottery drawing for a number of larger prizes (e.g. restaurant gift cards valued from \$10 to \$50, iPod Shuffles and Amazon Touch Kindles); one prize was awarded for every 15 surveys completed. Informed consent was obtained from the participants, and study procedures were approved by the Institutional Review Board.

### Instruments

The online survey assessed participants' demographic characteristics, positive emotions, adaptive and maladaptive

coping strategies, resilience, stress, trait anxiety and depressive symptoms. Each of these variables is further discussed in the following sections, and a copy of the survey may be requested from the corresponding author.

### Demographics

Participants were asked to report a variety of personal characteristics including age, sex, race/ethnicity, marital status, number of children, college/school (i.e. location of employment), employment length and nationality (i.e. country of origin). Because these demographic characteristics may be related to the dependent variables, the present study used them as covariates in the regression analyses.

### Positive emotions

The participants' experienced positive emotions were measured by the 10-item positive emotions subscale of the Modified Differential Emotions Scale (Fredrickson et al., 2003). Each item asked participants to recall how often they have experienced particular sets of positive emotions during the previous 2 weeks (e.g. 'In the past two weeks, I have felt amused, fun-loving, or silly.'). Response options ranged on a five-point scale from 0 (*never*) to 4 (*most of the time*). The positive emotions score was calculated as the sum of the 10 items; scores ranged from 0 to 40, with higher scores indicating higher frequencies of experienced positive emotions. Internal reliability for the positive emotion scale was found to be acceptable in previous research ( $\alpha = 0.79$ ; Fredrickson et al., 2003), and reliability was very good in the present study ( $\alpha = 0.87$ ).

### Coping strategies

The Brief Coping Orientations to Problems Experienced scale was used to evaluate the participants' utility of different coping strategies (Carver, 1997). For the purposes of the present study, this measure included six adaptive coping subscales (viz. active coping, planning, positive reframing, acceptance, emotional support and instrumental support) and six maladaptive coping subscales (viz. self-distraction, denial, venting, substance use, behavioural disengagement and self-blame). Each subscale was measured by two items, and participants were asked to report how often they had used certain coping strategies during stressful experiences, on a four-point response scale ranging from 1 (*not at all*) to 4 (*a lot*).

Sample adaptive coping items include 'I concentrate my efforts on doing something about the situation I'm in' (active coping), 'I try to come up with a strategy about what to do' (planning) and 'I try to see it in a different light, to make it seem more positive' (positive reframing). Sample maladaptive coping items include 'I turn to other activities to take my mind off things' (self-distraction), 'I say to myself "this isn't real"' (denial) and 'I say things to let my unpleasant feelings escape' (venting). The scores for both the adaptive

and maladaptive coping strategies were calculated as the sum of the 12 items (ranging from 12 to 48); higher scores represent greater use of the particular set of coping strategies. The present study recorded alpha coefficients of 0.77 and 0.66 for the adaptive and maladaptive subscales, respectively.

### Resilience

Participant resilience was assessed using the six-item Brief Resilience Scale (Smith et al., 2008). On a five-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), respondents indicated the extent to which they agreed with statements that evaluated their personal resilience or ability to recover from stress (e.g. 'I tend to bounce back quickly after hard times', 'It does not take me long to recover from a stressful event' and 'I usually come through difficult times with little trouble'). The resilience score was calculated as the mean of the six items; scores ranged from 1 to 5, with higher scores indicating higher levels of resilience. This scale demonstrated good to excellent internal reliability as reported by previous research with Cronbach's alphas ranging from 0.80 to 0.91 (Smith et al., 2008); the present study also found the scale to be reliable at  $\alpha = 0.89$ .

### Stress

This variable was assessed using the 10-item Perceived Stress Scale (Cohen & Williamson, 1988), which measured the appraised stressfulness of the respondents' life situations. The scale items asked participants to rate how often stressful events occurred during the past month on a five-point scale from 0 (*never*) to 4 (*very often*). Sample items include 'How often have you felt that you were unable to control the important things in your life?' and 'How often have you felt difficulties were piling up so high that you could not overcome them?' The stress score was calculated as the sum of the 10 items, ranging from 0 to 40, with higher scores representing higher levels of stress. Previous research found the internal reliability of the 10-item Perceived Stress Scale to range from acceptable ( $\alpha = 0.78$ ) to excellent ( $\alpha = 0.91$ ; Cohen & Janicki-Deverts, 2012), and the reliability from the present study was estimated at  $\alpha = 0.86$ .

### Trait anxiety

The 20-item trait anxiety subscale of the State-Trait Anxiety Inventory for Adults (Spielberger, Gorsuch, Jacobs, Lushene, & Vagg, 1968, 1977) was used to measure the participants' tendency to appraise stressful events as threatening and thus respond with heightened levels of state anxiety reactions (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983). Using a four-point scale ranging from 1 (*almost never*) to 4 (*almost always*), participants responded to items including, 'I feel nervous and restless' and 'I get in a state of tension or turmoil as I think over my recent

concerns and interests'. Scores for this variable were calculated as the sum of the 20 items, ranging from 20 to 80, with higher scores representing higher levels of trait anxiety. [Correction made here after initial online publication.] The trait anxiety subscale demonstrated very good to excellent internal reliability, with Cronbach's alphas ranging from 0.89 to 0.91 (Spielberger et al., 1983); the present study also recorded an excellent reliability score at  $\alpha = 0.91$ .

### Depressive symptoms

The Center for Epidemiologic Studies Depression scale was used to assess the participants' level of experienced depressive symptoms (Radloff, 1977). Consisting of 20 items, the instrument assessed how often respondents felt a variety of depressive symptoms during the previous week. Using a four-point scale ranging from 0 (*rarely or none of the time; less than 1 day*) to 3 (*most or all of the time; 5–7 days*), participants responded to statements such as 'I was bothered by things that usually don't bother me' and 'I did not feel like eating; my appetite was poor'. The Center for Epidemiologic Studies Depression score was calculated as the sum of the 20 items, ranging from 0 to 60, with higher scores representing higher levels of experienced depressive symptoms. A score of 16 or greater is considered a moderately severe level of symptoms and could be a marker for clinical depression (Radloff, 1977). Previous research found the internal consistency of the scale ranged from good to excellent ( $\alpha = 0.85–0.90$ ; Radloff, 1977), and the present study also demonstrated very good reliability at  $\alpha = 0.86$ .

### Analyses

All analyses were completed using the Statistical Package for the Social Sciences (SPSS) software version 21 (IBM Corporation, Armonk, NY, USA). Using the procedures detailed by Pallant (2010), preliminary tests were performed to ensure that the statistical assumptions of normality, linearity, outliers, multicollinearity, independence and homoscedasticity were satisfied before the regression analyses were conducted.

### Descriptive statistics and correlations

Means, standard deviations and bivariate correlations of all study variables were calculated using descriptive statistics, Pearson correlations for continuous variables, point-biserial correlations for continuous and dichotomous variables and chi-square tests for pairs of dichotomous variables.

### Mediation analysis

In order to test the direct and indirect associations among positive emotions, adaptive and maladaptive coping strategies and resilience, path analysis was performed with Preacher and Hayes' (2008) Model

INDIRECT script using bootstrap estimation. Demographic variables (viz. age, number of children, employment length, sex, marital status, college/school, race/ethnicity and nationality) were also included in the model as covariates.

As depicted in Figure 1, the relationship between positive emotions and resilience was hypothesized to be mediated by the two subscales of coping strategies (viz. adaptive and maladaptive) while controlling for the demographic variables. Therefore, this model examined several types of effects: the *direct* effects of positive emotions on resilience and each of the two subscales of coping strategies, as well as the *direct* effects of the two subscales of coping strategies on resilience; the *specific indirect* effect of positive emotions on resilience through each subscale of coping strategies (i.e. the unique mediating effect of each subscale of coping strategies while controlling for the other subscale); the *total indirect* effect of positive emotions on resilience (i.e. the sum of each of the two specific indirect effects); and the *total* effect of positive emotions on resilience (i.e. the sum of the direct and total indirect effect). For indirect paths, this analysis produced point estimates and three varieties of 95–99% confidence intervals (viz. percentile, bias corrected and bias corrected and accelerated) from 5000 bootstrap samples. Pairwise comparison of the indirect effects was also performed to determine if a particular mediator has a significantly stronger unique indirect effect than the other mediator.

### Moderation analysis

Guided by Aiken and West's interaction analysis method (1991), hierarchical multiple regression was

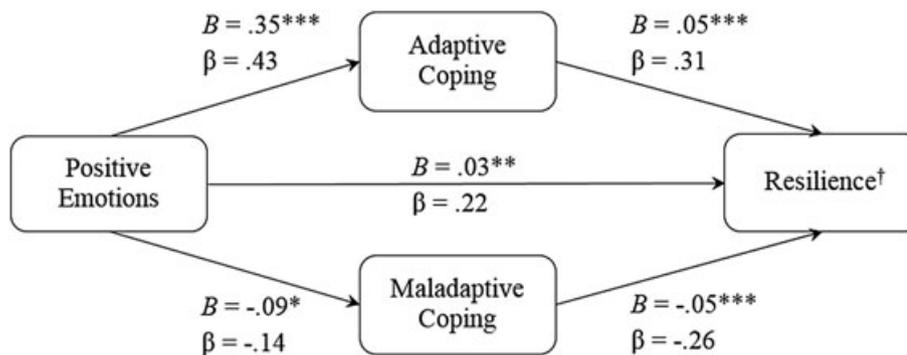
used to examine the moderating effect of resilience on the association between stress and the dependent variables (viz. trait anxiety and depressive symptoms); each of the dependent variables was tested individually using separate models. Demographic variables (viz. age, number of children, employment length, sex, marital status, college/school, race/ethnicity and nationality) were also included in each of the models as covariates.

Prior to analysis, values of all continuous predictors were centred to prevent potential problems associated with multicollinearity (Aiken & West, 1991). The hierarchical model of the multiple regression analysis consisted of three steps. In the first step, the demographic covariates were entered in the regression of the dependent variable. The second step involved the addition of the focal predictors, namely stress and resilience. In the third and final step, the interaction term between stress and resilience—stress  $\times$  resilience—was entered into the model. This three-step process was independently conducted for the regression of each of the dependent variables (viz. trait anxiety and depressive symptoms).

## Results

### Descriptive analysis

Data collection was conducted over a period of 2 weeks, and the study obtained a sample size of  $n = 200$  post-docs (38% response rate). This response rate exceeded expectations as previous studies with similar methods recorded lower return rates ranging from 17% to 25% (Deutskens et al., 2004; Evans & Mathur, 2005;



Indirect effect of positive emotions on resilience,  $B = .02$ ,  $\beta = .17^{**}$

Total effect of positive emotions on resilience,  $B = .05$ ,  $\beta = .39^{***}$

Model  $R^2 = .34^{***}$

Note:  $*p < .05$ ,  $**p < .01$ ,  $***p < .001$

†Controlling for age, number of children, employment length, sex, marital status, college/school, race/ethnicity, and nationality.

**Figure 1** Conceptual model of coping strategies partially mediating the relationship between positive emotions and resilience with unstandardized ( $B$ ) and standardized ( $\beta$ ) coefficients ( $n = 196$ )

Sax, Gilmartin, & Bryant, 2003); a meta-analysis of 56 web-based surveys from 39 studies reported an average response rate of 35% (Cook, Heath, & Thompson, 2000). However, due to partially missing demographic data (viz. age and college/school), four of the participants were dropped from the analyses, resulting in a final sample size of  $n=196$ ; three missing data points related to positive emotions and one from depressive symptoms were replaced via mean substitution.

Participants were primarily male (59.5%) with a mean age of 32 years, ranging from 26 to 52 years. In terms of race/ethnicity, 63.5% were non-Hispanic White or Caucasian, 18% Asian or Pacific Islander, 8.5% Hispanic or Latino, 7% Indian or South Asian, 0.5% Black or African American and 2.5% other. The majority were married (59.5%), 31% were single, 7% were living with a partner and the remaining 2.5% were either divorced or separated. Their family sizes ranged from having zero to four children; 71% had no children, 18.5% had one, 6% had two, 4% had three and one participant had four children. The participants were employed as postdocs for an average of 1.5 years and ranged from 1 year to 6 years and 8 months. The majority worked in the college of natural sciences (48.5%), 20% in engineering, 7.5% in liberal arts, 5.5% in geosciences, 5% in pharmacy and the remaining were in communication, education, public affairs, social work or other. Most of the postdocs originated from the United States (US) (50.5%), 10.5% China, 6.5% India, 4% South Korea, 3.5% United Kingdom, 3% Canada and the remaining were from 25 other countries around the globe.

Prior to the regression analyses, multiple-category demographic variables were collapsed into binary variables to produce appropriately sized groups: marital status (1 = *married*, 0 = *unmarried*), college/school (1 = *natural sciences*, 0 = *other*), race/ethnicity (1 = *non-Hispanic White/Caucasian*, 0 = *other*), and nationality (1 = *from US*, 0 = *other*). Age, number of children and employment length were retained as continuous variables.

Table I displays the means, standard deviations and correlations for all study variables. Positive emotions, adaptive coping and maladaptive coping were moderately correlated with resilience. Interestingly, adaptive coping strategies were found to be unrelated to maladaptive coping strategies, although previous research has reported a moderate correlation ( $r=0.30$ ,  $p < 0.01$ ; Meyer, 2001). The strongest correlations were among stress, trait anxiety and depressive symptoms. Among the demographic control variables, on average, US nationals used more maladaptive coping and were more resilient than non-US nationals, women reported greater use of adaptive coping, being married or having children was negatively associated with maladaptive coping and married postdocs reported fewer depressive symptoms.

## Mediation model

In terms of the direct effects shown in Figure 1, postdocs who experienced higher degrees of positive emotions used more adaptive coping ( $B=0.35$ ,  $p < 0.001$ ) and less maladaptive coping strategies ( $B=-0.09$ ,  $p < 0.05$ ). Adaptive coping was positively related to resilience ( $B=0.05$ ,  $p < 0.001$ ), whereas maladaptive coping had a negative association with resilience ( $B=-0.05$ ,  $p < 0.001$ ). After controlling for the two constructs of coping strategies and the set of demographic covariates, the direct relationship between positive emotions and resilience remained significant ( $B=0.03$ ,  $p < 0.01$ ), indicating that coping strategies did not completely mediate the link between positive emotions and resilience. Among the control variables, only employment length ( $B=0.09$ ,  $p < 0.05$ ) and nationality ( $B=0.21$ ,  $p < 0.05$ ) had significant associations with resilience.

As for specific indirect effects, the indirect effects of positive emotions on resilience were significant through both mediators: adaptive coping [ $B_{\text{boot}}=0.02$ ,  $\text{Bias}=0.0001$ ,  $\text{standard error (SE)}=0.004$ ,  $p < 0.01$  (99% bias corrected and accelerated confidence interval (CI): 0.01, 0.03)] and maladaptive coping [ $B_{\text{boot}}=0.004$ ,  $\text{Bias}=0.0000$ ,  $\text{SE}=0.002$ ,  $p < 0.05$  (95% bias corrected and accelerated CI: 0.0002, 0.01)]. Pairwise comparison of the two indirect effects indicated that the mediating path through adaptive coping was significantly stronger than through maladaptive coping [ $B_{\text{boot}}=-0.01$ ,  $\text{Bias}=-0.0002$ ,  $\text{SE}=0.01$ ,  $p < 0.05$  (95% bias corrected and accelerated CI:  $-0.02$ ,  $-0.002$ )]. Combining together the direct and indirect effects via coping strategies, the total effect of positive emotions on resilience was estimated at  $B=0.05$ ,  $p < 0.001$ . The overall model accounted for 34% of the total variance in resilience.

## Moderation model

### Trait anxiety

As displayed in Table II, the demographic control variables were entered into Model 1, but they did not significantly account for any variance in trait anxiety ( $F_{8, 187}=1.21$ ,  $p > 0.05$ ). Following the addition of stress and resilience in Model 2, the total variance explained was estimated at 70% ( $F_{10, 185}=42.92$ ,  $p < 0.001$ ). In the final step, Model 3, both stress ( $B=0.96$ ,  $p < 0.001$ ) and resilience ( $B=-4.77$ ,  $p < 0.001$ ) were associated with trait anxiety. To determine the role of resilience in moderating the association of stress on trait anxiety, the interaction term (stress  $\times$  resilience) was also included in the final model. The analysis revealed a significant interaction effect ( $B=-0.31$ ,  $p < 0.001$ ), indicating that resilience moderated the relationship between stress and trait anxiety. The final model explained an additional 2% and accounted for a total of 72% of the variance in trait anxiety ( $F_{11, 184}=43.53$ ,  $p < 0.001$ ).

**Table 1.** Means, standard deviations (SD) and bivariate correlations for all variables ( $n = 196$ )

Variable	Mean	SD	PE	AC	MC	R	S	TA	DS	A	NC	EL	F	M	NS	W	US
Positive Emotions (PE)	24.23	6.02	—														
Adaptive Coping (AC)	36.53	4.87	0.44***	—													
Maladaptive Coping (MC)	21.41	3.83	-0.15*	-0.02	—												
Resilience (R)	3.62	0.70	0.38***	0.38***	-0.29***	—											
Stress (S)	16.18	5.79	-0.47***	-0.19**	0.34***	-0.45***	—										
Trait Anxiety (TA)	39.74	9.14	-0.53***	-0.38***	0.46***	-0.61***	0.77***	—									
Depressive Symptoms (DS)	10.61	7.59	-0.49***	-0.24**	0.44***	-0.42***	0.72***	0.75***	—								
Control																	
Age (A)	32.08	3.71	0.08	0.04	-0.03	0.10	-0.04	-0.05	-0.01	—							
Number of Children (NC)	0.44	0.82	0.09	0.05	-0.18*	0.10	-0.00	-0.10	-0.12	0.46***	—						
Employment Length (EL)	1.49	1.23	-0.13	-0.14	-0.07	0.13	0.04	0.09	0.04	0.26***	0.16*	—					
Female (F) <sup>†</sup>	—	—	0.02	0.22**	0.07	0.02	0.01	-0.03	-0.08	-0.04	0.01	-0.17*	—				
Married (M) <sup>†</sup>	—	—	0.01	0.04	-0.19**	0.13	-0.06	-0.13	-0.18*	0.14	0.43***	0.15*	0.04	—			
Natural Sciences (NS) <sup>†</sup>	—	—	0.01	-0.03	-0.13	0.11	-0.11	-0.06	-0.10	0.01	0.05	0.21**	-0.00	0.12	—		
White (W) <sup>†</sup>	—	—	0.05	-0.07	0.10	0.11	-0.07	-0.09	0.01	0.03	0.08	0.02	0.09	-0.07	-0.05	—	
US American (US) <sup>†</sup>	—	—	-0.02	0.06	0.15*	0.16*	-0.02	-0.02	0.06	0.00	0.01	0.02	0.21**	-0.03	0.02	0.48***	—

<sup>†</sup>Sex (Female = 1, Male = 0); Marital Status (Married = 1, Unmarried = 0); College/School (Natural Sciences = 1, Other = 0); Race/Ethnicity (White = 1, Other = 0); Nationality (US = 1, Other = 0). \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

**Table II.** Hierarchical regression of trait anxiety on controls, focal predictors and the interaction term ( $n = 196$ )

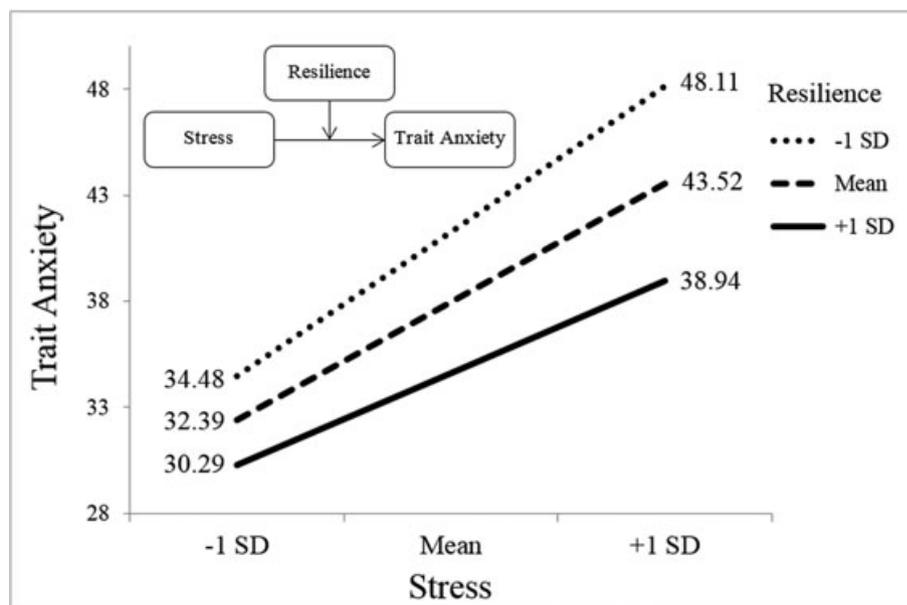
Variable	Model 1			Model 2			Model 3		
	<i>B</i>	SE <i>B</i>	$\beta$	<i>B</i>	SE <i>B</i>	$\beta$	<i>B</i>	SE <i>B</i>	$\beta$
Age	-0.11	0.20	-0.04	0.05	0.12	0.02	0.01	0.11	0.01
Number of Children	-0.39	0.99	-0.04	-0.79	0.56	-0.07	-0.64	0.54	-0.06
Employment Length	1.10	0.57	0.15	0.88	0.33	0.12**	0.99	0.32	0.13**
Female <sup>†</sup>	0.09	1.38	0.01	-0.25	0.78	-0.01	0.07	0.76	0.00
Married <sup>†</sup>	-2.34	1.49	-0.13	0.74	0.85	-0.04	-0.59	0.82	-0.03
Natural Sciences <sup>†</sup>	-1.50	1.34	-0.08	0.33	0.76	0.02	0.29	0.74	0.02
White <sup>†</sup>	-2.16	1.56	-0.11	-0.67	0.89	-0.04	-0.92	0.85	-0.05
US American <sup>†</sup>	0.52	1.51	0.03	1.13	0.86	0.06	1.34	0.83	0.07
Stress				0.95	0.07	0.60***	0.96	0.07	0.61***
Resilience				-4.64	0.61	-0.35***	-4.77	0.59	-0.36***
Stress X Resilience							-0.31	0.08	-0.16***
Model $R^2$			0.05			0.70			0.72
<i>F</i> for change in $R^2$			1.21			199.44***			15.65***

<sup>†</sup>Sex (Female = 1, Male = 0); Marital Status (Married = 1, Unmarried = 0); College/School (Natural Sciences = 1, Other = 0); Race/Ethnicity (White = 1, Other = 0); Nationality (US = 1, Other = 0).

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .

Post hoc probing of the significant interaction was conducted according to the methods of Aiken and West (1991). Plotting the interaction was performed to illustrate the regression of trait anxiety on varying degrees of stress and resilience. As shown in Figure 2, levels of stress and resilience were estimated at one standard deviation below and above their means as recommended by Aiken and West. Results showed that the simple slopes from all three levels of resilience—at -1 standard deviation (SD), mean and +1 SD—were statistically significant ( $p < 0.001$ ). The graph indicated that increasing levels of stress were likewise

associated with increasing levels of trait anxiety. However, as suggested by the significant interaction effect, resilience appeared to have a moderating effect on the link between stress and trait anxiety. In other words, postdocs with higher levels of resilience seemed to be protected from the impact of stress and thus explaining their lower scores of trait anxiety as compared with those with lower levels of resilience. The protective role of resilience was apparent across all levels of stress, but the degree of protection was largest when stress levels were highest. [Correction made here after initial online publication.]

**Figure 2** The moderating effect of resilience on the relationship between stress and trait anxiety

### Depressive symptoms

As displayed in Table III, the demographic control variables were entered into Model 1, but they did not significantly account for any variance in depressive symptoms ( $F_{8, 187} = 1.49, p > 0.05$ ). Following the addition of stress and resilience in Model 2, the total variance explained was estimated at 58% ( $F_{10, 185} = 25.38, p < 0.001$ ). In the final step, Model 3, both stress ( $B = 0.90, p < 0.001$ ) and resilience ( $B = -1.40, p < 0.05$ ) were associated with depressive symptoms. To determine the role of resilience in moderating the association of stress on depressive symptoms, the interaction term (stress  $\times$  resilience) was also included in the final model. The analysis revealed a significant interaction effect ( $B = -0.28, p < 0.001$ ), indicating that resilience moderated the relationship between stress and depressive symptoms. The final model explained an additional 3% and accounted for a total of 61% of the variance in depressive symptoms ( $F_{11, 184} = 25.81, p < 0.001$ ).

Post hoc probing of the significant interaction was conducted according to methods of Aiken and West (1991). Plotting the interaction was performed to illustrate the regression of depressive symptoms on varying levels of stress and resilience. As shown in Figure 3, levels of stress and resilience were estimated at one standard deviation below and above their means. Results showed that the simple slopes from all three levels of resilience—at  $-1$  SD, mean and  $+1$  SD—were statistically significant ( $p < 0.001$ ). The graph indicated that increasing levels of stress were likewise associated with increasing levels of depressive symptoms. However, as suggested by the significant interaction effect, resilience appeared to have a moderating effect on the

link between stress and depressive symptoms. Particularly when stress levels are high, postdocs with higher levels of resilience seemed to be protected from the impact of stress and thus explaining their lower scores of depressive symptoms as compared with those with lower levels of resilience. However, the protective role of resilience appeared to be unimportant when stress levels were low, but the degree of protection became more apparent as stress levels increased. Considering the cutoff score of 16 or higher (suggesting moderately severe level of symptoms and a possible marker for clinical depression), results indicated that postdocs with high levels of resilience remained below this criterion even when stress levels were high.

### Discussion

Using a sample of  $n = 200$  postdocs, the present study was conducted to (a) examine if positive emotions were associated with greater resilience, (b) test whether coping strategies mediated the link between positive emotions and resilience and (c) investigate if resilience moderated the influence of stress on trait anxiety and depressive symptoms, after controlling for a variety of demographic variables. As hypothesized, there was a positive association between positive emotions and resilience, and coping strategies partially mediated the link between positive emotions and resilience. Results also indicated that resilience moderated the impact of stress on trait anxiety and depressive symptoms.

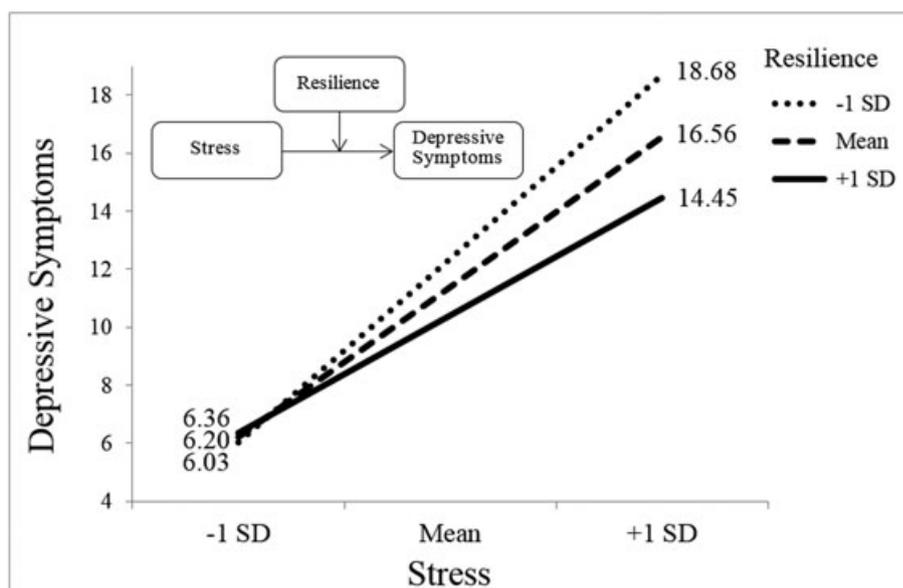
With respect to the broaden-and-build theory of positive emotions, findings from the mediation analysis provided further support for the theory's build hypothesis (Fredrickson, 2004, 2005; Kok et al., 2008), as

**Table III.** Hierarchical regression of depressive symptoms on controls, focal predictors and the interaction term ( $n = 196$ )

Variable	Model 1			Model 2			Model 3		
	<i>B</i>	SE <i>B</i>	$\beta$	<i>B</i>	SE <i>B</i>	$\beta$	<i>B</i>	SE <i>B</i>	$\beta$
Age	0.06	0.17	0.03	0.18	0.11	0.09	0.15	0.11	0.07
Number of Children	-0.70	0.82	-0.08	-1.09	0.55	-0.12	-0.95	0.54	-0.10
Employment Length	0.44	0.47	0.07	0.10	0.32	0.02	0.21	0.31	0.03
Female <sup>†</sup>	-1.21	1.14	-0.08	-1.52	0.77	-0.10*	-1.22	0.75	-0.08
Married <sup>†</sup>	-2.29	1.23	-0.15	-1.25	0.83	-0.08	-1.12	0.81	-0.07
Natural Sciences <sup>†</sup>	-1.50	1.11	-0.10	-0.13	0.75	-0.01	-0.17	0.73	-0.01
White <sup>†</sup>	-0.54	1.29	-0.03	0.59	0.87	0.04	0.36	0.84	0.02
US American <sup>†</sup>	1.32	1.25	0.09	1.34	0.85	0.09	1.53	0.82	0.10
Stress				0.88	0.07	0.67***	0.90	0.07	0.68***
Resilience				-1.27	0.60	-0.12*	-1.40	0.59	-0.13*
Stress $\times$ Resilience							-0.28	0.08	-0.17***
Model $R^2$			0.06			0.58			0.61
<i>F</i> for change in $R^2$			1.49			113.77***			13.28***

<sup>†</sup>Sex (Female = 1, Male = 0); Marital Status (Married = 1, Unmarried = 0); College/School (Natural Sciences = 1, Other = 0); Race/Ethnicity (White = 1, Other = 0); Nationality (US = 1, Other = 0).

\* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .



**Figure 3** The moderating effect of resilience on the relationship between stress and depressive symptoms

demonstrated by the significant direct associations of positive emotions with resilience and coping strategies. Positive emotions' positive relationship with adaptive coping strategies, and negative relationship with maladaptive strategies, indicated that positive emotions may have the ability to enhance adaptive coping while minimizing maladaptive coping strategies. An increase in adaptive coping in conjunction with a decrease in maladaptive coping, in turn, would consequently have a building influence on resilience.

In addition, the direct association between positive emotions and resilience indicates that positive emotions may not only have the potential to increase resilience, but that resilience may also have the ability to increase positive emotions, supporting the theory's hypothesis that a reciprocal relationship between positive emotions and resilience could spark an upward spiral toward increasing emotional well-being (Fredrickson & Joiner, 2002); the same argument may also apply for an upward spiral between positive emotions and coping (Burns et al., 2008). Therefore, in order to optimize resilience among postdocs, it is important to implement programmes that would aim to increase individual use of adaptive coping strategies, decrease use of maladaptive coping strategies and increase experiences of positive emotions. In turn, enhanced levels of resilience would enable postdocs to adapt more successfully when dealing with stressful situations. From a practical standpoint, interventions have been successful in eliciting enhanced positive emotions and the accompanying resilience resources (Emmons & McCullough, 2003; Seligman, Steen, & Park, 2005).

As for the moderation analyses, results support the buffering hypothesis of Fredrickson's broaden-and-build theory (Kok et al., 2008). In line with expectations, resilience demonstrated a moderating role toward the impact of stress on trait anxiety and depressive symptoms, as found in previous research (Aroian & Norris, 2000; Pinquart, 2009; Wagnild, 2003). That is to say, as stress levels increased, levels of trait anxiety and depressive symptoms also increased; however, individuals with higher levels of resilience exhibited some level of protection, as demonstrated by their lower scores of trait anxiety or depressive symptoms, compared with other participants who possessed lower levels of resilience.

Regarding trait anxiety, postdocs with higher resilience appeared to be protected across the full range of stress; even when stress is low, postdocs with high resilience already had lower scores on trait anxiety, and the degree of protection—or the difference in trait anxiety between low and high resilience—further increased as stress magnified. In contrast, with respect to depressive symptoms, one's level of resilience did not seem to be important when stress levels are low; however, having high levels of resilience protected postdocs from increased depressive symptoms as stress levels increased.

Importantly, those with average or low levels of resilience were projected to have depressive symptoms that were above the tipping point for clinical levels of depression (Radloff, 1977) [Correction made here after initial online publication.]. Thus, enhancing the resilience of postdocs may help prevent an increase in the prevalence of mental health disorders. Although stress is unavoidable and the associations among stress, anxiety and depression are undeniable, the link between postdocs and whether they will develop anxiety

or depression may be ameliorated by implementing programmes designed to increase their resilience, adaptive coping and positive emotions.

With respect to the findings regarding the participants' nationality, we found small but significant correlations between US postdocs and maladaptive coping ( $r=0.15$ ,  $p<0.05$ ), and between US postdocs and resilience ( $r=0.16$ ,  $p<0.05$ ). Although future research is needed, it may be that some postdoc stressors are not within one's control. Given this, maladaptive coping strategies might actually help postdocs manage their stress more effectively in certain situations. Looking at the coping means, adaptive coping is higher than maladaptive coping, and so on balance, one's percentage of problem-focused coping relative to total coping (adaptive + maladaptive) is indicative of a healthy coping style. The small significant relationship between US postdocs and resilience makes intuitive sense given they are 'at home', and thus, it may be easier for them to manage their stressors; furthermore, they may have more social/instrumental/emotional support available to them than postdocs whose country of origin is outside of the United States. Importantly, we also point out that we controlled for nationality in the regression analyses, which enhances confidence in our results.

Results from the present study should be considered in light of the following limitations. The present study used cross-sectional data, and thus, causality and directionality cannot be determined from the found associations among the variables. It is also possible that the data may be vulnerable to inaccuracies due to common-methods bias and the self-report nature of the online survey instrument. The participants were recruited from a pool of postdocs who were employed at a large research institution in the state of Texas, USA. There were no exclusion criteria, and all postdocs from any college or department across the university were allowed to participate. Due to this localized sampling, results and implications may not be applicable to postdocs from other institutions, locations or time. Ad-

ditional drawbacks of the present study's methods include an increased risk for a self-selected sample and the voluntary nature of the study.

No specific clinical evaluation of anxiety and depression was available. Therefore, it is possible that a number of factors beyond the measures of this study could have influenced the participants' self-reported scores (e.g. use of prescription drugs and unexpected event). However, although such factors may affect one's self-assessment, this effect would not have an unexpected influence on the relationships under examination. For instance, if a participant were experiencing high levels of stress and depressive symptoms, this positive correlation between stress and depressive symptoms would nonetheless remain the same even if the participant were under the influence of an anti-stress/depression drug and consequently feeling low levels of stress and depressive symptoms. Likewise, if a participant with an anxiety disorder were functioning effectively with medication, his or her data would reflect this mindset. Although prescription drugs may significantly change one's self-assessment, this effect should not have an unexpected influence on the relationships under examination.

In conclusion, findings from the present study provide additional support for the build and buffering hypotheses of the broaden-and-build theory of positive emotions. Results suggested that positive emotions may have the ability to fuel resilience directly, as well as indirectly by promoting adaptive coping and demoting maladaptive coping strategies. Although stress was strongly associated with trait anxiety and depressive symptoms, resilience could protect postdocs from developing clinical levels of anxiety and depression. In order to maintain and enhance the well-being of postdocs, programmes should be implemented to increase their positive emotions, adaptive coping and resilience.

## Conflict of interest

The authors have declared that there is no conflict of interest.

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