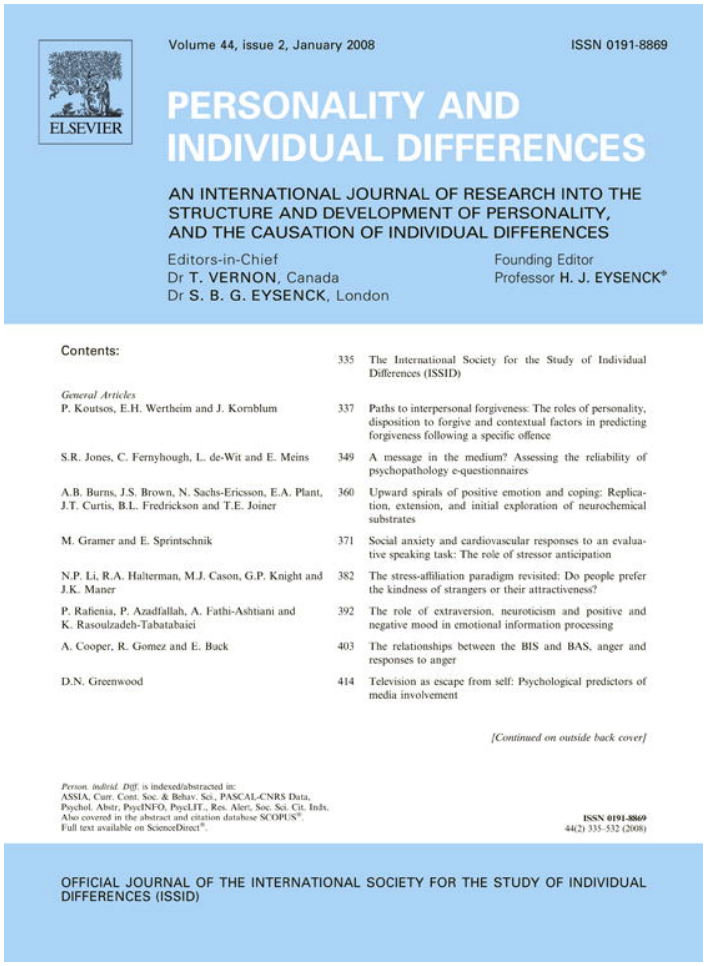

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Upward spirals of positive emotion and coping: Replication, extension, and initial exploration of neurochemical substrates

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Abstract

The broaden-and-build theory (Fredrickson, 1998, 2001) predicts that positive emotions broaden the scopes of attention and cognition, thereby facilitating the building of personal resources and initiating upward spirals toward increasing emotional well-being. This study attempts to replicate and extend previous empirical support for this model. Using a sample of 185 undergraduates, we assessed whether positive affect and broad-minded coping, interpersonal trust, and social support reciprocally and prospectively predict one another over a two-month period, and whether this upward spiral might be partially based in changes in dopaminergic functioning. As hypothesized, PA and positive coping did mutually build on one another, as did PA and interpersonal trust. Contrary to expectation, PA did not demonstrate an upward spiral relation with social support. Results suggest further study of the relationship between PA and changes in dopamine metabolite levels over time is warranted.

Keywords: Emotion; Coping; Broaden-and-build; Affect; Trust

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1. Introduction

Positive emotional experiences not only feel good, they also help people stay healthy (Cohen, Doyle, Turner, Alper, & Skoner, 2003) and live longer (Danner, Snowdon, & Friesen, 2001), even accounting for age, gender, prior health status, social class, and other possible confounds (Levy, Slade, Kunkel, & Kasl, 2002; Moskowitz, 2003; Ostir, Markides, Black, & Goodwin, 2000). But *how* do pleasant feelings promote health and well-being?

Fredrickson's (1998, 2001) *broaden-and-build theory* suggests possible pathways. The theory holds that positive emotions *broaden* people's thought-action repertoires, encouraging them to discover novel lines of thinking and behavior. A key, incidental outcome of these broadened mindsets is an increase in personal resources: As individuals discover new ideas and actions, they *build* physical, intellectual, social, and psychological resources. Aspects of the broaden-and-build perspective have received empirical support in past work, which has shown positive emotions to broaden the scope of people's visual attention, widen their thought-action repertoires, and enhance intuitive and creative thinking and coping skills (Bolte, Goschke, & Kuhl, 2003; Fredrickson & Branigan, 2005; Isen, Daubman, & Nowicki, 1987).

Only one study, however, has examined the *reciprocal* nature of the relation between positive emotions and personal resources. Fredrickson and Joiner (2002) empirically demonstrated that positive emotions broaden the scopes of attention and cognition, and by consequence initiate upward spirals toward increasing emotional well-being. These authors studied undergraduates' self-reported affect and coping at two assessment periods, five weeks apart. As hypothesized, results indicated that positive affect (PA) predicted improved broad-minded coping, and broad-minded coping predicted increased PA. Further analyses showed that PA and broad-minded coping serially enhanced one another: the broadened attention and cognition triggered by earlier experiences of positive emotion facilitated coping, which in turn predicted future experiences of positive emotion. All findings were specific to PA; similar patterns with negative affect (NA) were not evident. This study provided prospective evidence to support the prediction that positive emotions initiate upward spirals toward enhanced emotional well-being via enhanced coping.

Our purpose in the present study is to replicate the findings of Fredrickson and Joiner (2002), and to extend them in several ways. First, whereas Fredrickson and Joiner (2002) rationally selected a specific coping subscale as an index of broad-minded coping, we utilize a broader, factor-analytically derived coping composite. Second, we seek to demonstrate that upward spirals involve interpersonal as well as cognitive resources and benefits. The broaden-and-build theory posits that positive emotions facilitate approach behaviors that motivate people to explore and interact with their environment in a variety of ways, which in turn should foster the development of an array of physical, cognitive, and social resources (Fredrickson, 2001). Accordingly, in addition to assessing coping (a cognitive resource) we assess the social resources of interpersonal trust and social support. Finally, there is intriguing preliminary evidence that the effect of positive emotions on "enlarging" the cognitive context is linked to increases in brain dopamine. Ashby, Isen, and Turken (1999) reviewed the literature on PA and cognition and proposed a theory postulating that increased CNS dopaminergic activity mediates the association between PA and improvements in various cognitive skills including creative problem solving and selection of cognitive perspective. An exploratory aim of our study is to empirically assess whether the upward spiral of positive emotions and broad-minded coping is related to changes in dopaminergic functioning.

Utilizing an undergraduate sample, we assessed PA, NA, positive and negative coping, trust, social support, and neurotransmitter metabolites at two sessions separated by approximately two months. Our first hypothesis is that PA predicts improvements in positive coping (PC), trust, and social support over time. Our second hypothesis is that PC, trust, and social support predict increases in PA over time. Additionally, we test whether similar relations hold for NA, and predict specificity to PA. Our third and fourth hypotheses test upward spiral relations directly. We predict that initial PA predicts subsequent PA, in part through changes in PC, trust, and social support. Similarly, we predict that initial PC predicts subsequent PC, in part through changes in PA. Support for these hypotheses would suggest that PA and PC serially influence one another, consistent with the broaden-and-build theory and the findings of Fredrickson and Joiner (2002).

Finally, we explore the role of homovanillic acid (HVA), the main dopaminergic metabolite, in these associations, and we compare it to the role of 5-hydroxyindoleacetic acid (5-HIAA), the main serotonergic metabolite. While this is an exploratory aspect of our study, based on the literature reviewed by Ashby et al. (1999) we expect a positive relation between PA and dopaminergic functioning, and we expect whatever role is demonstrable for dopamine to exceed that for serotonergic functioning.

2. Method

2.1. Participants and procedure

Undergraduate participants received credit in introductory psychology for participating in two sessions, conducted in groups. Two hundred and twenty students participated at Time 1 (T1), and 185 (144 female; ages 16–46, $M = 18.8$ years; 65% Caucasian, 15% African–American, 11% Hispanic, 2% Asian–American, 7% other) returned for the second session approximately eight weeks later (T2). The 35 participants who dropped out did not differ from those who completed on any variable of interest. At T1 participants provided consent, completed questionnaire measures, and provided a urine sample. At T2 they completed identical measures and provided a second urine sample.

2.2. Measures

2.2.1. Positive and negative affect scale (PANAS; Watson, Clark, & Tellegen, 1988)

The PANAS includes two 10-item scales, one for PA and one for NA. Respondents indicated the extent to which they felt each of 20 feelings/emotions during the past two weeks. Scores for PA and NA range from 10 to 50, with higher scores indicating more PA and NA, respectively. Coefficient alpha for PA was .84 at T1 and .88 at T2; for NA it was .88 at T1 and .85 at T2.

2.2.2. Coping responses inventory (CRI; Moos, 1988)

Respondents chose an important, recent problem from their own lives, and indicated on a Likert-type scale how often they had used various coping strategies to deal with it. The CRI-Adult Form yields eight rationally-derived subscales. Four scales assess "approach" coping behaviors: Cognitive Analysis, Positive Reframing, Seeking Counsel, and Problem Solving. The other four

assess "avoidance" coping: Seeking Alternative Rewards, Emotional Discharge, Avoidance, and Acceptance/Resignation. We factor-analyzed the T1 data on these eight scales (using PCA and varimax rotation), and a clear two-factor solution emerged. Factor analysis of the T2 CRI data produced highly similar findings.

The first factor comprised the Cognitive Analysis, Positive Reframing, Seeking Counsel, Problem Solving, and Seeking Alternative Rewards subscales. This factor involves broad-minded, proactive, and engaged approaches to coping, and was termed "Positive Coping" (PC). Coefficient alpha for this composite scale was .82 at T1 and .86 at T2. The second factor comprised the Avoidance and Acceptance/Resignation subscales. This factor involves resigned and less assertive approaches compared to the first factor, and was termed "Avoidance/Resignation Coping (A/RC)".[1] Coefficient alpha for this composite was .64 at T1 and .69 at T2. To our knowledge, no previous study has factor-analyzed the CRI-Adult Form in its entirety. Griffith, Dubow, and Ippolito (2000) factor-analyzed the items of the CRI-Youth Form after adolescent participants completed the form for three separate domains of stressors (family, school, peer). Their results supported a two-factor solution entirely consistent with our findings.

2.2.3. Eating disorders inventory (EDI; Garner, Olmsted, & Polivy, 1983)

Interpersonal trust was assessed using the Interpersonal Distrust subscale of the EDI, a 64-item self-report measure of eating-related attitudes and traits. This subscale includes seven items designed to measure interpersonal distrust. Participants rated items on a 6-point Likert-type scale, anchored by (1) = never and (6) = always. Responses were reverse-scored for this study so that higher scores reflected higher *trust*. Coefficient alpha was .86 at T1, and .85 at T2.

2.2.4. Social support questionnaire (SSQ; Sarason, Levine, Basham, & Sarason, 1983)

Social support was assessed with an abbreviated, six-item form of the SSQ. Each item asks participants to (a) list the people to whom they can turn and on whom they can rely in given sets of circumstances and (b) indicate their level of satisfaction with these social supports on a 6-point Likert-type scale anchored by (1) = very dissatisfied and (6) = very satisfied. Total number of supportive individuals listed was tallied and satisfaction ratings were summed across the six-items to provide a summary index of satisfaction. Coefficient alpha for number of supports in the present sample was .93 at T1 and .95 at T2; for satisfaction it was .98 at T1 and .99 at T2.

2.3. Assays for dopamine and serotonin metabolites

Using high-performance liquid chromatography (HPLC), we assayed urine samples for HVA and 5-HIAA. Both indices are crude proxy measures of central function, as (among other confounds) only a minority of the neurotransmitters and metabolites in urine originate in central neurons (Amin, Davidson, & Davis, 1992). However, assessment of urine concentration of metabolites is unquestionably the least invasive method of estimating central function available, and such concentrations have been used as reasonable proxies in past studies (e.g., De Bellis, Lefter, Trickett, & Putnam, 1994).

[1] The Emotional Discharge subscale loaded significantly and positively onto both factors. Accordingly, this subscale of the CRI was excluded from further analyses.

All urine samples were collected at either 2:00 pm or 3:00 pm to control for diurnal variation in neurochemical levels. Initial preparation of samples was conducted by adding 100 ul of 0.1 N perchloric acid to 500 ul of urine sample. Samples were centrifuged at 14,000 rpm to precipitate out any protein. The supernatant was then transferred to vials for HPLC analysis. Peak separation was achieved using an Alliance Separations Module (Waters, Inc.), a microdialysis MD-150 analytical column (ESA, Inc.) and mobile phase (0.7 ml/min) consisting of 75 mM sodium dihydrogen phosphate monohydrate (EM Science), 1.7 mM 1-octanesulfonic acid sodium salt (Acros), 0.01% triethylamine (Aldrich), 25 μM EDTA (Fisher), 10% acetonitrile (EM Science); pH adjusted to 3.29 with 85% phosphoric acid (Fisher). Electrochemical detection of analytes was performed using an ESA Coulochem detector. Ten microliter samples were oxidized at 300 mV and peak areas were converted to analyte amount based on comparisons to standards of known concentration.

3. Results[2]

Descriptive statistics for all variables of interest are presented in Table 1.

3.1. Does PA predict improved PC, trust, and social support?

3.1.1. Coping

Our first hypothesis was that T1 PA (but not NA) would predict changes in PC (but not A/RC), trust, and social support from T1 to T2, such that those participants reporting more PA at T1 would experience more increases in PC, trust, and support over time. To test the first part of this prediction we constructed a regression equation with T2 PC as the dependent variable. Because we were interested in whether *ongoing* experiences of PA and PC contribute to changes over time in one another, we predicted changes from T1 to T2 in one variable with the T1–T2 average (mean) of the predictor variable.[3] First, T1 PC was entered into the regression. Next, averaged T1–T2 versions of NA and A/RC were entered. Finally, averaged T1–T2 PA was entered. Listwise deletion was utilized to account for missing data. Results are displayed in Table 2. All of our expectations regarding PC received support. PA was associated with increased PC ($pr = .16$, $t(149) = 1.97$, $p = .05$), but NA was not.

To test the association between PA and changes in the A/RC index, we next constructed a regression equation arranged like the one above but using T2 A/RC as the dependent variable. As expected, PA was not found to be significantly associated with increased A/RC. NA, however, was significantly associated with increased A/RC, $pr = .34$, $t(149) = 4.41$, $p < .001$.

[2] Neither gender nor age moderated effects, and thus will not be discussed further. Degrees of freedom vary due to missing data on some variables.

[3] An alternative approach would be to use the T1 version of the predictor to predict changes from T1 to T2 in the dependent variable. Results using this approach were consistent with those reported in text, but weaker. We believe this is to be expected, because use of the T1 version of the predictor captures processes occurring at T1 and before, whereas we are interested in processes occurring between T1 and T2, better captured by the average of the T1 and T2 predictors.

Table 1
Descriptive statistics

Variable	T1 Mean (SD)	T2 Mean (SD)
PA	37.90 (6.06)	37.42 (6.92)
NA	21.47 (6.99)	20.33 (6.33)
Positive Coping	72.74 (16.74)	68.55 (18.95)
A/R Coping	27.88 (7.34)	26.37 (7.54)
Trust	32.75 (6.87)	32.75 (6.51)
# of Supports	33.89 (13.53)	33.19 (13.74)
Satisfaction w/Support	30.92 (8.53)	29.47 (10.03)
HVA	0.15 (0.07)	0.14 (0.05)
5-HIAA	0.29 (0.19)	0.30 (0.16)

Note: HVA = homovanillic acid (ng/100 μL); 5-HIAA = 5-hydroxyindoleacetic acid (ng/100 μL).

Table 2
Multiple regression assessing predictors of T2 positive coping

Block	Variables entered	*F* for block	df	*t* for Predictors	Partial correlation (pr)
1		66.72***	1, 148		
	T1 PC			8.17***	.56
2		25.25***	3, 146		
	Average NA			−0.44	−.04
	Average A/RC			2.49**	.20
3		20.28***	4, 145		
	Average PA			1.97*	.16

Note: PC = Positive Coping; A/RC = Avoidance/Resignation Coping.
* $p \leqslant .05$.
** $p \leqslant .01$.
*** $p \leqslant .001$ level.

3.1.2. Trust

To assess whether PA was associated with improved trust over time we constructed a regression equation with T2 trust scores as the DV. T1 trust, averaged T1–T2 versions of NA, PC, and A/RC, and averaged T1–T2 PA were entered sequentially as predictors. PA was found to have a marginally significant association with increased trust, $pr = .16$, $t(149) = 1.92$, $p = .057$. As expected, NA did not demonstrate a significant association.

3.1.3. Support

To test the final part of our first hypothesis, we constructed two regression equations, arranged like those referred to above, now with T2 number of social supports and T2 satisfaction with social support as the DVs. Contrary to expectation, PA was not found to be significantly associated with either increased number of social supports or increased satisfaction with social support. NA was not found to be significantly associated with number of social supports; however, NA significantly predicted *decreased* satisfaction with social support, $pr = -.20$, $t(149) = -2.41$, $p < .05$.

3.2. Do PC, interpersonal trust, and social support predict increased PA?

Our second hypothesis predicted that PC (but not A/RC), trust, and social support would predict changes in PA (but not NA) from T1 to T2. To test this hypothesis we first constructed a regression equation with T2 PA as the DV. T1 PA was entered first into the equation. Next, averaged T1–T2 versions of NA and A/RC were entered. Finally, averaged versions of PC, interpersonal trust, number of social supports, and satisfaction with social support were entered. Results are presented in Table 3. As predicted, PC was associated with increased PA ($pr = .21$, $t(142) = 2.49$, $p = .01$), but A/RC was not associated with PA. Also as predicted, interpersonal trust was associated with increased PA, $pr = .20$, $t(142) = 2.30$, $p < .05$. However, neither number of social supports nor satisfaction with social support was predictive of T2 PA.

To test specificity to PA we constructed a second regression with T2 NA as the DV. T1 NA, averaged T1–T2 versions of PA and A/RC and, averaged PC, interpersonal trust, number of supports, and satisfaction with support were entered sequentially as predictors. As expected, PC was not predictive of NA. However, interpersonal trust was found to be predictive of decreased NA, $pr = -.26$, $t(142) = -3.18$, $p < .01$. Similarly, satisfaction with social support was predictive of decreased NA, $pr = -.17$, $t(142) = -1.94$, $p = .05$.

3.3. Is PA involved in upward spirals with PC and interpersonal trust?

Our third hypothesis was that T1 PA would predict T2 PA, partly as a function of predicting changes in PC and interpersonal trust (social support was dropped from this prediction based on the results presented above). Similarly, our fourth hypothesis was that the predictive relationship between T1 PC and T2 PC would be partially mediated by changes in PA. In both cases, such mediation would suggest an upward spiral relationship between PA, PC, and trust. To assess these hypotheses we utilized the four steps of mediational analyses described by Kenny, Kashy, and Bolger (1998).

Table 3
Multiple regression assessing predictors of T2 positive affect

Block	Variables entered	*F* for Block	df	*t* for Predictors	Partial correlation (pr)
1		188.06***	1, 142		
	T1 PA			13.71***	.76
2		62.82***	3, 142		
	Average NA			−1.15	−.10
	Average A/RC			0.47	.04
3		30.96***	7, 142		
	Average PC			2.49**	.21
	Average Trust			2.30*	.20
	Average # Supports			0.06	.01
	Average Satisfaction w/Support			0.34	.03

* $p \leqslant .05$.
** $p \leqslant .01$.
*** $p \leqslant .001$.

Step 1 in determining whether PC and trust function as mediators in the change of PA over time (hypothesis 3) is to show that predictor (T1 PA) and outcome (T2 PA) are significantly correlated; as illustrated in Table 3, this step is satisfied. Step 2 is to show that the predictor (T1 PA) is correlated with the proposed mediators (averaged PC and interpersonal trust). Results supported significant bivariate correlations between T1 PA and both averaged PC ($r = .20$, $p = .01$) and averaged trust ($r = .44$, $p < .001$). Step 3 is to show that the proposed mediators (PC and trust) predict the outcome variable (T2 PA), controlling for the predictor (T1 PA). As illustrated in Table 3, this step was accomplished by analyses already reported. Step 4 is to evaluate whether the relationship between predictor and outcome is significantly decreased or eliminated when controlling for the mediators. Results indicated that controlling for PC and trust, the relationship between T1 PA and T2 PA remains significant ($pr = .72$, $p < .001$) but slightly weaker than when the mediators are not included ($pr = .78$), suggesting partial mediation.

To assess our fourth hypothesis, we first established a significant correlation between predictor (T1 PC) and outcome (T2 PC), $r = .54$, $p < .001$. Second, we evaluated the association between predictor and mediator (averaged PA); results indicated a marginal correlation ($r = .14$, $p = .08$). Step three, demonstrating the significant association between mediator and outcome, controlling for predictor, is illustrated in Table 2. Finally, controlling for PA, the association between T1 PC and T2 PC was only slightly weakened (from $pr = .55$ to $pr = .53$), again supporting only partial mediation.

3.4. Exploratory analyses of relations between psychological variables and dopaminergic and serotonergic metabolites

As a final extension upon Fredrickson and Joiner's (2002) work, we explored whether averaged T1–T2 composites of HVA and 5-HIAA would be predictive of changes in PA, NA, PC, A/RC, interpersonal trust, and the social support measures. There were no significant findings. We next considered whether averaged T1–T2 versions of PA, NA, PC, A/RC, trust, and the social support measures would be predictive of changes over time in HVA and 5-HIAA metabolites. To explore this question, we constructed two regression equations, predicting T2 HVA and T2 5-HIAA, respectively. T1 HVA/5-HIAA was entered first, followed by PA, NA, PC, A/RC, trust, and the social support measures entered simultaneously in the second block. In the equation predicting T2 HVA no predictors other than T1 HVA reached statistical significance, although intriguingly, the only predictor approaching significance was PA ($p = .096$). In the equation predicting T2 5-HIAA, PA was not predictive.

4. Discussion

Our aim in this study was to replicate and extend tests of the broaden-and-build theory of positive emotions. Following the empirical strategy used by Fredrickson and Joiner (2002), we examined the reciprocal relations between PA and increments over time in personal resources. While observed effect sizes were small, our findings replicated those reported by Fredrickson and Joiner (2002). As predicted, PA was positively associated with PC over time and vice versa; furthermore,

evidence of partial mediation was consistent with the hypothesized "upward spiral" relationship between these variables. Furthermore, we replicated the construct specificity reported by Fredrickson and Joiner (2002): no association was found between NA and PC.

Our efforts to extend the work of Fredrickson and Joiner (2002) proved fruitful as well. We replicated their results utilizing an index of PC derived factor-analytically rather than rationally. The factor analysis also yielded an index of more avoidant, "negative" coping strategies (A/RC), which we found to be unrelated to PA, consistent with the broaden-and-build model. Third, we observed comparable upward spiral relations between PA and the social resource of interpersonal trust, providing further evidence that resources other than coping style are influenced by positive emotions. And fourth, we found some preliminary evidence to suggest that certain neurochemicals (HVA, 5-HIAA) may be worthy of exploration as variables in the association between emotion and personal resources. While our findings with our crude proxy measure assayed from urine samples were insignificant, the modest observed relationships suggest that more fine-grained biochemical research in this area may prove illuminating.

Of note, our hypothesis that PA would show upward spiral relations with social support was not supported. Having observed similar null relations in other (unpublished) datasets, we speculate that quantity-based indices of social support may be too crude to show the impact of positive emotions, and that this may account for the absence of any effects of the size of participants' social networks. However, we likewise failed to find any association between participants' *satisfaction* with the support provided by their social networks and PA (although NA *did* demonstrate an inverse association with support satisfaction). We note that while PA, coping styles, and trust are all characteristics of the individual, satisfaction with social support depends on characteristics and behaviors of others in the interpersonal environment. Such a distinction may suggest that any mutual influence between participants' PA and their satisfaction with their social networks may operate on a different (longer) time scale than the associations between PA and coping style, and may therefore be unobservable over a two-month time frame.

It is worth noting that we observed some interesting relationships between NA, satisfaction with social support, trust, and A/RC. As noted above, low trust and satisfaction with social support was predictive of increased NA over time. Likewise, higher NA was predictive of increased A/RC and decreased satisfaction with social support over time. These findings are suggestive of a possible *downward* spiral between NA and maladaptive coping strategies, interpersonal distrust, and dissatisfaction with one's social support network. Such a spiral would be comparable to the "depressive spiral" of negative emotions and maladaptive cognitions and behaviors described by McCullough (2000) and others (e.g., Joiner, 2000), and it will be important for future work to explore this possibility further.

This study was subject to several limitations, including the utilization of urine samples already addressed, and the reliance on self-report measures of coping, which may be subject to biases of self-perception and recall. To this end, it is noteworthy that we obtained stronger findings for the reciprocal association between PA and interpersonal trust (a variable less dependent on recall) than we found for PA and PC. To the extent that future studies can obtain more accurate neurochemical estimates (e.g., through blood or CSF samples, or collection of multiple urine samples over a 24-h period), and more objective indices of coping strategies, the relations between these variables might be brought into clearer relief. Replication of this study using non-student population will also be important for establishing the external validity of our results.

The clinical implications of our findings are worth underscoring. Clinicians who induce positive emotions (e.g., by asking patients to think about their "best times") or who time skill-based interventions to correspond to patients' naturally-occurring positive moods may increase the chances that patients will more rapidly and fully learn therapy-based skills (Wingate et al., 2006). Previous research has empirically substantiated the beneficial impact of positive emotional experiences on treatment outcome, even among suicidal patients (Joiner et al., 2001). More generally, evidence for upward spiral relations suggests that people's experiences of positive emotions—although fleeting—may carry largely unsung value. These findings, together with the broaden-and-build theory, suggest that experiencing positive emotions opens windows of opportunity to build enduring personal resources which can later function as reserves when people face inevitable crises and adversity. The opportunity to accrue personal resources during positive states not only illuminates a pathway through which positive emotions may promote healthy longevity, but also gives people reason to cultivate, protect, and value their experiences of positive emotions.

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