HHS Public Access
Author manuscript
J Pers. Author manuscript; available in PMC 2018 October 01.

Published in final edited form as:
J Pers. 2017 October ; 85(5): 675–686. doi:10.1111/jopy.12270.

Dispositional Affect Moderates the Stress-Buffering Effect of Social Support on Risk for Developing the Common Cold

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Abstract

Objective—To examine whether trait positive and negative affect (PA, NA) moderate the stress-buffering effect of perceived social support on risk for developing a cold subsequent to being exposed to a virus that causes mild upper respiratory illness.

Method—Analyses were based on archival data from 694 healthy adults (mean age = 31.0±10.7 years; 49.0% female; 64.6% Caucasian). Perceived social support and perceived stress were assessed by self-report questionnaire and trait affect by aggregating responses to daily mood items administered by telephone interview across several days. Subsequently, participants were exposed to a virus that causes the common cold and monitored for 5 days for clinical illness (infection + objective signs of illness).

Results—Two 3-way interactions emerged—Support x Stress x PA and Support x Stress x NA. The nature of these effects was such that among persons with high trait PA or low trait NA, greater social support attenuated the risk of developing a cold when under high but not low perceived stress; this stress-buffering effect did not emerge among persons with low trait PA or high trait NA.

Conclusions—Dispositional affect might be used to identify individuals who may be most responsive to social support and support-based interventions.

Keywords

Common Cold Project; perceived stress; social support; trait affect

INTRODUCTION

Social support refers to the psychological and material resources provided by a social network to benefit an individual's ability to cope with stressful events (e.g., Cassel, 1976; Cobb, 1976; Cohen, 2004; Thoits, 1986). As such, *perceived* social support refers to the individual's subjective assessment of the potential availability of these resources *should the*

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Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

need for them arise (Cohen & Hoberman, 1983). Thus, it has been proposed that any psychological or physical health benefits that might be associated with social support are most likely to be received when the supported individual is suffering from some form of adversity. This *buffering hypothesis* stands in contrast to the main effects hypothesis which purports that the beneficial effects of social support for psychological and physical health are unqualified by the experience of stress (Cohen & Wills, 1985; House, 1981).

Converging evidence from psychological, epidemiological, and medical research has provided evidence in support of the buffering hypothesis. For example, the perceived availability of social support has been found to protect against the potential of stressful events to elicit psychological distress, depression, and anxiety (for reviews, see Cohen & Wills, 1985; Kawachi & Berkman, 2001; Schwartzer & Leppin, 1989; Uchino, 2004). Perceived support also may protect against stress-elicited increases in risk for physical morbidity and mortality (Falk, Hanson, Isacsson, & Ostergren, 1992; Rosengren, Orth-Gomer, Wedel, & Wilhelmsen, 1993).

Several factors influence the effectiveness of social support in buffering the adverse effects of stress on psychological and physical health outcomes (Cohen & Syme, 1985). These include features of the stressor, such as severity and chronicity; the nature of the available support—especially in regard to how well it matches the need elicited by the stressor (Cohen & McKay, 1985; Cutrona & Russell, 1990); and the identity of the support provider—i.e., whether that individual is an appropriate source of the required resources.

Dispositional characteristics of the support recipient as well may play an important role in determining the effectiveness of social support as a stress-buffer (Pierce, Lakey, Sarason, & Sarason, 1997). Individuals' perceptions of support are themselves thought to reflect the interplay of both inter- and intrapersonal processes (Sarason, Sarason, & Shearin, 1986; Lakey & Scoboria, 2005). The personality characteristic of extraversion, for example, has been associated with both greater perceived availability of social support (Sarason, Sarason, Brock & Pierce, 1996) and being more sensitive to the stress-ameliorating effects of specific supportive behaviors (Cutrona, Hessling, & Suhr, 1997). Other stable characteristics such as mastery (Hobfoll & Lerman, 1988), self-esteem (Kong, Zhou, & You, 2013), and locus of control (e.g., Lefcourt, et al 1984; Cauce, Hannan, & Sargeant, 1992) also have been found to influence the stress-buffering effect of social support, with higher levels of each trait being associated with greater received benefit.

Another individual difference characteristic that may influence whether one receives optimal stress-buffering benefits from social support is trait affect. Trait positive affect (PA) describes the general tendency to experience positive emotions, such has happiness, enthusiasm, and serenity. By contrast, trait negative affect (NA) refers to the dispositional tendency to experience negative emotions, such as anger, anxiety, and sadness.

In addition to more frequently experiencing pleasurable affect, individuals who score higher on measures of trait PA also have been found to have more favorable opinions of their social relationships (Lyubomirsky, King, & Diener, 2005), to express more satisfaction with their friendships (Watson & Clark, 1984; Watson, Hubbard, & Wiese, 2000) and to generally be more trusting of other persons (Tov & Diener, 2008; Dunn & Schweitzer, 2005). Thus, it seems reasonable to hypothesize that high trait PA individuals may be more likely to glean psychological and physical health benefits from their relationships with supportive others than do those who are low in trait PA.

Trait NA, on the other hand, may contaminate an individual's judgement of the effectiveness of proffered social support (Watson & Tellegen, 1985) and contribute to greater dissatisfaction with the support that they receive (Den Oudsten et al., 2010). Moreover, potential support providers may be disinclined to offer their resources to social network members with high levels of trait NA (Dehle & Landers, 2005). Thus, even among individuals who perceive themselves as having support available to them, those with high levels of trait NA may not benefit to the same extent as persons with less trait NA from the actual support they receive in times of need. Indeed, neuroticism—the Big Five cognate of trait NA—has been found to moderate the stress-buffering effect of social support on self-reported chronic health conditions and self-rated health (Park et al., 2012). Specifically, among community-dwelling Japanese (but not North American) adults, receipt of social support was associated with fewer self-reported chronic conditions and better self-rated health when perceived stress was high but not when perceived stress was low, with the effect being more pronounced at lower relative to higher levels of neuroticism (Park et al, 2012).

The aim of the present study is to examine whether trait PA and NA moderate the stress-buffering effect of perceived social support on the risk for developing a cold subsequent to being experimentally exposed to a virus that causes mild upper respiratory illness. In a previous viral-challenge study, we found that perceived stress was associated with increased risk of developing a cold (Cohen, Tyrrell, & Smith, 1991; Cohen, Tyrrell, & Smith, 1993). Thus, in keeping with the buffering hypothesis, we expect that the association of perceived social support with cold risk will be moderated by perceived psychological stress, such that a protective effect of support on cold risk will be evident at higher but not lower levels of perceived stress. We further propose that this stress-moderated effect of social support on cold risk will be enhanced among those with higher trait levels of PA and lower trait levels of NA.

METHOD

Participants

The analyses presented here combined archival data from three viral-challenge studies (Pittsburgh Cold Study 2 [PCS2], the Pittsburgh Mind-Body Center Cold Study [PMBC] and Pittsburgh Cold Study 3 [PCS3]) that followed a common set of procedures. These procedures included a physical exam, questionnaire assessments of demographics, perceived stress, and social support, an evening interview protocol assessing daily positive and negative emotions, and subsequent participation in a viral-challenge trial. The total sample consisted of 702 participants (334 in PCS2, 155 in PMBC, and 213 in PCS3). PCS2 was conducted between 1997 and 2001, PMBC was conducted between 2000 and 2004, and PCS3 was conducted between 2007 and 2011. The maximum available sample size was employed. The participants were healthy adults between the ages of 18 and 55 years (M = 31.1, SD = 10.7).

Participants from all three studies were recruited from the Pittsburgh, Pennsylvania, metropolitan area via newspaper advertisements and community postings. All participants provided informed consent and received financial compensation for participation. Study procedures were approved by the appropriate institutional review boards. The total sample was 48.7% female (51.3% male) and 35.8% non-White (30.8% African American; 1.4% Asian or Pacific Islander; 0.7% Native American, Eskimo, or Aleut; 0.9% Hispanic or Latino; and 2.0% of "other" race or ethnicity). Roughly one-quarter (27.8%) of participants had less than or equal to a high school education, and 22.4% had earned at least a bachelor's degree. Eight participants were missing data on relevant covariates and thus were excluded from the present analyses, which left a final sample of 694.

Procedure

Figure 1 depicts the temporal sequence of study activities. Volunteers underwent medical screenings and were excluded from study eligibility if they had a history of psychiatric illness, asthma, or cardiovascular disorders; had undergone major nasal or otologic surgery; had an abnormal urinalysis, complete blood count, or blood enzymes; were pregnant or currently lactating; tested seropositive for HIV; or took regular medication (except birth control). In all 3 studies, demographics, weight and height also were assessed at screening. Subsequently, volunteers were quarantined in separate rooms, exposed to either of 2 viruses that cause a mild common cold-like illness (rhinovirus [RV] 23 or RV39) and followed for 5 days to assess infection and signs and symptoms of illness.

Perceived stress and social support were assessed by questionnaire during the extended baseline period between screening and viral challenge. Trait positive and negative affect were assessed by telephone interview two to five weeks prior to quarantine. In PCS2, interviews were conducted during two 3-day periods separated by one week. In PMBC and PCS3, interviews were conducted over the course of 14 consecutive evenings. The data used for the present analyses as well as extensive documentation of the measures and procedures employed by each of the three studies can be obtained from the *Common Cold Project* website (www.commoncoldproject.com).

Measures

Disease Outcomes—Infectious diseases arise as the result of growth and activation of invading microorganisms or parasites within the body (see Cohen & Williamson, 1991). Infection is the replication (multiplication) of the invading organism. Clinical disease occurs when the infected host displays symptoms and signs characteristic of disease.

Infection: Two methods were used to confirm the presence of infection with the challenge virus. The first involved examination of participants' nasal secretions after they had been exposed to the virus. When upper respiratory viruses replicate, they can be found in nasal-secretion samples. Samples were collected daily in a saline wash of the nose, frozen and then later cultured for the challenge virus (i.e., placed in a medium that stimulates virus replication). If the virus is present in the nasal secretion samples, it will grow in the culture medium where it subsequently can be detected. Using this method, participants were considered to be infected with the challenge virus if evidence of the virus was detected from cultured nasal secretion samples collected on any of the 5 post-challenge days. The second method involved comparing the amount of antibody to the challenge virus (viral-specific antibody) in blood samples collected prior to and 28 days following viral challenge. Because the immune system responds to infection by producing antibody to the virus, increases in viral-specific antibody level provide an indirect marker of infection. Using this method, participants were considered to be infected with the challenge virus if they showed a 4-fold or greater increase in the amount of viral-specific antibody present in their blood from pre- to 28 days post-challenge (Gwaltney, Colonno, Hamparian, & Turner, 1989).

Signs of illness: Two objective markers of upper respiratory illness were assessed: nasal mucus production and nasal mucociliary clearance function. Daily mucus production was assessed by collecting used tissues in sealed plastic bags (Doyle, McBride, Swarts, Hayden, & Gwaltney, 1988). The bags were weighed, and the weight of the tissues and bags was subtracted to determine the weight of mucus produced. Clearance function refers to the effectiveness of nasal cilia in clearing mucus from the nasal passage toward the throat. Ineffective clearance function is subjectively experienced as congestion. Clearance function was assessed by determining the time required for a saccharin-dyed solution administered into the anterior nose to be tasted by the participant (Doyle et al., 1988).

To create baseline-adjusted daily scores for each measure, the appropriate baseline score (from the day before the challenge virus was administered) was subtracted from each of the 5 post-challenge daily scores (Cohen et al., 1997). Negative adjusted scores were reassigned a value of 0. Total daily mucus production was computed by summing the adjusted daily scores across the 5 post-challenge days. Average nasal-clearance time was calculated by taking the mean of the adjusted daily scores over all post-challenge days.

Clinical illness (colds): Participants were determined to have developed a clinical cold if they both were infected with the challenge virus and met either of the following criteria: total baseline-adjusted mucus weight of 10 g or more, or average (across all post-challenge days) baseline-adjusted nasal mucociliary clearance time of 7 min or longer (Cohen et al., 1997).

Psychological and Social Variables Assessed at Baseline—*Perceived psychological stress* was assessed using the10-item version of the Perceived Stress Scale (PSS-10; Cohen, Kamarck, & Mermelstein, 1983; Cohen & Williamson, 1988), which was designed to tap the extent to which respondents find their lives to be unpredictable, uncontrollable, and overloading. Response options were presented on a 5-point scale ranging from 0 (*never*) to 4 (*very often*), and participants were instructed to respond in reference to the past month. Four of the 10 items were worded in a positive direction, and thus were reverse-scored. The responses to the 10 items were then summed to create a psychological stress score, with higher scores indicating greater stress. In the present sample, the internal reliability (Cronbach'sα) for the PSS was .87.

Perceived social support was assessed using the 12-item version of the Interpersonal Support Evaluation List (ISEL; Cohen, Mermelstein, Kamarck, & Hoberman, 1985; http://www.psy.cmu.edu/~scohen/ISEL12.html). The ISEL-12 contains items drawn from three of the four subscales included in the original scale, with each subscale being represented by the four highest-loading component items. Items assess the availability of persons with whom the respondent can talk about his or her problems, persons with whom the respondent can spend time doing things, and persons who would provide the respondent with material aid if needed. Participants responded to each item on a 4-point scale ranging from 0 (*definitely false*) to 3 (*definitely true*). Total perceived support scores were derived by summing the 12 items. Because positive and negative items on the scale were counterbalanced, negatively stated items (indicating low support) were reverse-scored prior to computing the total score. In the present sample, Cronbach's α for the scale was .84.

Trait positive and negative affect: During each of the pre-quarantine evening telephone interviews, participants were asked to rate, using a 5-point scale (0 = *haven't felt that way at all*, 4 = *felt that way a lot*), the extent to which a series of positive and negative mood adjectives described how they had been feeling during the preceding 24 hours. The positive adjectives represented three subcategories of positive emotion: vigor (lively, full of pep), well-being (happy, cheerful), and calm (at ease, calm); and the six negative adjectives represented three subcategories of negative emotion: depression (sad, unhappy), anxiety (on edge, tense), and hostility (hostile, angry) (Usala & Hertzog, 1989). Daily positive and negative mood scores were calculated by summing the ratings of the six respective adjectives. Cronbach's α for the daily assessments ranged from 0.82 to 0.93 for positive and 0.83 to 0.92 for negative mood scores. To form summary measures of trait positive and negative affect (PA and NA, respectively), positive and negative daily mood scores were averaged across the 6 (PCS2) or 14 (PMBC, PCS3) interview days (Cohen, Doyle, Turner, Alper, & Skoner, 2003; Cohen, Alper, Doyle, Treanor, & Turner, 2006). We previously have shown aggregated daily measures of PA to correlate well with traditional questionnaire measures (r = .49, p = .001; Cohen et al., 2003). Because the distribution of trait NA scores was strongly skewed toward lower values, scores were $\log_{10}$-transformed prior to analysis.

The multiple measurement technique was chosen because of evidence that single global retrospective emotional assessments are more representative of recent emotional experiences and of peak experience than they are of the average over the specified time period (Stone, 1995). In our previous work (Cohen et al., 2003; Cohen et al., 2006), both retrospective and aggregated measures of affect predicted susceptibility to clinical upper respiratory illness; but the association was substantially stronger when we used the average of the daily affect rather than the retrospective recall measure.

Standard Control Variables—Data also were collected on nine control variables (covariates in analyses). Five of these variables have previously been found to predict clinical illness in our research: study (PCS2, PMBC, PCS3), virus type (rhinovirus [RV] 23, RV39), viral-specific immunity (the pre-exposure level of specific antibody to the challenge virus), season of the year (spring, summer, fall, winter), and body mass index (BMI; weight in kilograms/height in meters^2). The remaining four variables are demographic characteristics that traditionally are included in analysis of biomedical data because of their historical associations with psychosocial factors and various disease outcomes: age (continuous), sex (male, female), race (white, other) and educational attainment (as a proxy for socioeconomic status; high school or less, some college, ≥ 2 years with degree or certificate, bachelor's degree or greater).

Statistical Analyses

Statistical analyses were performed using IBM SPSS Version 21 (IBM Corp., Armonk, NY). Multi-variable logistic regression was used to examine the roles of dispositional affect, perceived stress, social support and their interactions in becoming infected with the challenge virus and in developing clinical illness. Models examining 2-way interactions included the main effects of the predictor (X) and moderator (Z) and the XZ cross-product term. Models examining 3-way interactions included the main effects of X, Z, and the second moderator (W), as well as all relevant two-way interactions (i.e., XZ, XW, WZ), and the relevant three-way XZW interaction. All variables (i.e., predictor, moderators, and covariates) were centered at their respective means prior to conducting the analyses. Significant analyses were followed up with additional models controlling for (a) the five biological and study-related control variables that have been found to be associated with clinical illness in our research and (b) the four demographic variables that historically have been included in our analyses of cold risk. Table 1 displays the intercorrelations among all variables included in the main analyses.

Significant 3-way interactions were examined using the Johnson-Neyman technique (Johnson & Neyman, 1936). Specifically, we used the PROCESS macro (Hayes, 2013) in SPSS to examine the XZW interaction and identify the regions of significance (Johnson&Neyman, 1936) for each moderated effect. To further explore the nature of the 3-way interactions, the moderated XY interactions were then plotted at 1 standard deviation (SD) above and below the mean of W (Aiken & West, 1991; Hayes & Matthes, 2009).

Main effects are reported as odds ratios (ORs) with 95% confidence intervals (CIs); interaction effects as unstandardized regression coefficients (Bs) with standard error (SE). Chi-square (χ^2) values are provided to indicate the improvement in prediction associated with the addition of the 3-way interaction term to the model. P values are reported for all analyses and all tests of significance are two-tailed.

RESULTS

Buffering Effect of Perceived Social Support on Stress-Related Risk of Developing a Cold

Of the 694 participants comprising the present sample, 524 (75.5%) became infected with the challenge virus and 205 (29.5%) met criteria for a clinical cold.

Results of separate logistic regression analyses that included only the main effects of social support and perceived stress, respectively, revealed no direct association of either variable on risk of developing a cold (social support, OR = 0.99, 95% CI = 0.96, 1.02, p = .418 [see also Cohen, Janicki-Deverts, Turner, & Doyle, 2015]; perceived stress, OR = 1.00, 95% CI = 0.98, 1.03, p = .85). Moreover, results of a model including the Support x Stress interaction in addition to the main effects of both social support and perceived stress indicated that the lack of association between social support and cold risk was consistent across levels of perceived stress and thus failed to provide support for the buffering hypothesis (interaction, $B = -0.002$, SE = 0.002, $p = .23$).

Moderation of Buffering Effect by Trait Positive and Negative Affect

To examine whether the buffering effect of social support depends on individuals' trait levels of positive and negative affect, three additional logistic regression analyses were conducted for PA and NA, respectively. The first analysis (see Table 2, Model 1) included the main effects of perceived stress, perceived social support, and PA or NA, all relevant 2-way interactions (i.e., Support x Stress, Support x PA [or NA], and Stress x PA [or NA]), and the Support x Stress x PA (or NA) interaction. The second analysis (see Table 2, Model 2) elaborated on Model 1 by also including the 5 covariates previously found to predict susceptibility to upper respiratory illness (pre-challenge antibody level, virus, season of the year, study, and body mass index). The third analysis (see Table 3, Model 3) elaborated on Model 2 by further including the 4 demographic variables that historically have been controlled for in our research (age, sex, race, educational attainment). As indicated by Table 2, both PA and NA emerged as significant moderators of the stress-buffering effect of social support on cold risk. Moreover, these effects persisted even with additional control for relevant biological, study-related, and demographic variables. For the sake of efficiency, all subsequent results are reported only for analyses that include the 9 additional control variables.

Analyses of the Support x Stress x Affect interactions with the Johnson-Neyman technique identified a centered PA score 1.45 (37.61% above, 62.39% below) and a centered NA score of −0.01 (55.04% above and 44.96% below) as the respective transitions between a statistically significant and non-significant moderating effect of social support on the association of perceived stress with cold risk. The nature of each 3-way interaction was further explored by examining the Support x Stress interaction at 1 SD above and below the respective means for trait PA and NA (Aiken & West, 1991; Hayes & Matthes, 2013). Results of these analyses are displayed graphically in Figures 2 and 3. As suggested by Figure 2, the buffering effect of social support on stress-related cold risk became increasingly apparent at higher trait levels of PA (+1 SD PA, $B = -0.008$, SE = 0.003, $p = .012$; −1 SD PA, $B = 0.001$, SE = 0.003, $p = .81$). Specifically, among persons with greater PA, increases in social support were associated with decreases in cold risk when perceived stress was high but was unrelated to cold risk when perceived stress was low.

Findings for NA were consistent inasmuch as the stress-buffering effect of social support became increasingly apparent at *lower* levels of NA ($B = -0.008$, SE = 0.003, $p = .013$), but was not observed at higher NA ($B = -0.001$, SE = 0.004, $p = .75$; −1 SD). As depicted in Figure 3, the nature of the effect among persons with a lower trait levels of NA was comparable to that among persons with greater PA: social support decreased the likelihood of developing a cold under conditions of high perceived stress but was unrelated to cold risk when perceived stress was low.

Infection and Colds Among Infected Participants

The buffering effect of social support on stress-related cold risk at higher PA and lower NA, respectively, may be due to a stress-buffering effect on risk for becoming infected with the challenge virus, on developing a cold among persons already infected with the virus, or on both processes. Thus, the three-way interactions were tested again, first to predict infection in the entire sample ($n = 694$) and then to predict colds among the infected subset ($n = 524$). Results of these analyses are presented in Table 3. As indicated by the table, the buffering effect of social support on stress-related cold risk appears to be accounted for in large part by an effect on the likelihood of developing illness signs and symptoms after having been infected with the challenge virus.

Independent Moderating Effects of Trait Positive and Negative Affect

Consistent with the findings of previous research (e.g., Cohen et al., 2003; Wilson, Gullone, & Moss, 1998), PA and NA were only moderately inversely correlated (present sample, $r = -.43$, $p = .001$; PCS2 only, $r = -.48$, $p = .001$; Cohen et al., 2003), thus suggesting that positive and negative affect do not simply represent opposite ends of a single affective continuum. Given this relative independence of PA and NA, it is possible that their associated moderating effects may contribute independently to the variance in cold risk. To test this hypothesis, both 3-way Support x Stress x Trait Affect interactions were entered into a single model along with all 5 component 2-way interactions and the standard covariates. When examined in this way, the Support x Stress x NA interaction emerged as an independent predictor of cold risk ($B = 0.015$, SE = 0.007, $p = .030$) whereas the Support x Stress x PA interaction did not ($B = 0.000$, SE = 0.001, $p = .69$).

Exploratory Analysis: Additive Effect of Trait Positive and Negative Affect

In addition to their independent effects it is possible that the combination of PA and NA may exert a stronger influence on the stress-buffering effects of social support than either trait alone, with those scoring both high on PA and low on NA being the most protected and those scoring both low on PA and high on NA being at greatest risk. Because the present study was inadequately powered for rigorous examination of the 4-way Support x Stress x PA x NA interaction, we explored the possibility of an additive effect by splitting the sample into those who scored in both the highest tertile of PA and lowest tertile of NA (n = 129), those who scored in both the lowest tertile of PA and highest tertile of NA (n = 121), and all others (n = 444). Separate examination of the Support x Stress interaction by level of the categorical PA/NA variable revealed a significant stress-buffering effect of social support on cold risk among those in the high PA/low NA category (Support x Stress, $B = -0.025$, SE = 0.010, $p = .010$) but not among those in either the low PA/high NA or intermediate categories, respectively (Support x Stress *p*s > .68).

DISCUSSION

Using archived data from three viral-challenge studies conducted between 1997 and 2011, the present analyses provide suggestive evidence that the stress-buffering effects of perceived social support on risk for developing a cold may be dependent upon individuals' relative levels of trait positive and negative affect (PA and NA, respectively). Specifically, the expected stress-dependent protective effect of perceived social support was observed at higher trait levels of PA and lower trait levels of NA. By comparison, the Support x Stress interaction did not emerge as significant either among individuals scoring lower on PA or among those scoring higher on NA. When both three-way interactions were examined simultaneously, only the Support x Stress x NA interaction remained an independent predictor of cold risk, thus suggesting a greater impact of negative relative to positive affect in moderating the stress-buffering effects of social support. Results of exploratory analyses examining the additive effects of PA and NA further suggest that those who are both high in PA and low in NA may receive the greatest stress-buffering benefits.

The present moderating effect of NA is consistent with findings reported by Park and colleagues (2012) in their cross-cultural examination of the three-way interactive effect of stress, social support, and neuroticism—the Big Five cognate of trait negative affect—on chronic health conditions and self-rated health. In that study, receipt of social support was associated with fewer chronic conditions and better self-rated health when perceived stress was high but not when perceived stress was low. Furthermore and in parallel with the present findings for NA, the Support x Stress interaction was more pronounced at lower levels of neuroticism (Park et al, 2012).

Moderation of the stress-buffering effect of perceived social support by trait affect may be due to both *intra*- and *inter*personal factors that influence the accuracy with which the appraisals of available support made by persons with differing affective profiles reflect the support they actually receive when facing stress. One such factor relates to how readily individuals seek assistance from the members of their social networks. The approach-avoidance literature proposes that separate appetitive and aversive motivational systems underlie individuals' predispositions toward positive and negative affect, respectively, with the former facilitating behavior and the latter inhibiting it (Gable, Reis, & Elliot, 2000; Carver, Sutton, & Scheier, 2000). In regard to the mobilization of one's support network, the same approach orientation that fosters positive affect may also encourage proactive solicitation of aid from potential support providers. By contrast, the avoidance orientation underlying negative affect may inhibit persons with high dispositional NA from seeking support even when it is available to them.

Trait affect also might influence the extent to which potential support-providers respond to an individual's needs. Individuals with high trait levels of PA tend to be personally engaging and well-liked (Lyubomirsky, King, & Diener, 2015). Thus, it is possible that the members of a high PA individual's social network may be more inclined to offer support than would be members of a low PA individual's network. On the other hand, social network members may be less motivated to provide support to individuals with high NA because the ultimate success of their support efforts might seem less certain. Trait affect has been found to influence stress appraisals, with the perceived severity of stressors increasing with increasing NA (e.g., Eaton & Bradley, 2008). Also, persons with higher levels of NA are more likely than others to report experiencing distress in the absence of an objective stressor (Watson & Clark, 1984). Consistent with this explanation, in the present sample PA was correlated positively ($r = .27$) and NA negatively ($r = -.21$) with perceived availability social support.

Finally, PA and NA also might influence the extent to which individuals effectively utilize the support that they have been given. PA has been associated with both greater self-confidence (Lee & Bobko, 1994) and greater optimism (Chang & Sanna, 2001). Coupled with high PA persons' general tendency to trust others (Tov & Diener, 2008; Dunn & Schweitzer, 2005) these correlated traits might increase the likelihood that high PA persons relative to their lower PA counterparts will follow supportive advice. By contrast, the negative views of self and others commonly held by persons with high NA (Watson & Clark, 1988) may reduce the likelihood that they will attempt to follow up on helpful suggestions.

Although the primary hypothesis of the present study was that the stress-buffering effect of perceived social support on cold risk would be qualified by PA and NA, the nonsignificant two-way Support x Stress interaction (when examined without the three-way interaction in the model) was unexpected. Nevertheless, this pattern of results is not without precedent. Borja and colleagues (2009) found that perceived social support (assessed with the ISEL) among victims of sexual trauma—another specific and potent stressor—was differentially associated with depression risk depending on the victims' scores on a measure of neuroticism. As in the present study, the authors found no overall association of social support with stress-related risk for depression, but did find a trend for support to attenuate risk at lower but not higher levels of neuroticism (Borja, Callahan, & Rambo, 2009).

The present study is not without limitations. First, no data were collected on either actual receipt of or satisfaction with social support thus preventing the examination of these two factors as possible contributors to the observed effects. Second, whereas assessments of PA and NA were collected across multiple days, perceived stress and social support were each assessed at only a single time point. Also, it is possible that our simultaneous analysis of the Support x Stress x PA and Support x Stress x NA interactions may have underestimated the independent moderating effect of PA. As indicated in Table 1, PA and NA were positively correlated ($r = -.42$). The affect measure employed in the present study was based on the Profile of Mood States (POMS, Usala & Hertzog, 1989) which encompasses the full range of activated and unactivated positive and negative affective states, thus permitting some degree of intercorrelation between the two constructs. Had we employed an affect measure such as the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) which focuses largely on high activation components of PA and NA and thus favors the emergence of orthogonal traits, we may have found independent effects of both 3-way interactions. Finally, the present study was correlational, thus limiting causal inference. However, the prospective viral-challenge paradigm eliminates reverse causation as an alternative explanation for the present findings. As measures of all predictors and moderators were administered prior to participants' exposures to the challenge virus, neither infection with the virus nor subsequent illness expression could have influenced participants' ratings of stress, social support, or trait affect.

Viewed in light of the findings from extant research examining the moderating effects of trait negative affect on the stress-buffering capacity of social support (Park et al., 2012; Borja et al., 2009), the present study provides further evidence that certain individuals may benefit more than others in regard to their potential to derive health-protective benefits from the support provided by their social networks. Importantly, whereas previous research indicated a moderating effect of trait negative affect on the stress-buffering effect of social support on risk for self-reported physical health (Park et al., 2012) and depressive symptoms (Borja et al., 2009), the present study provides evidence that this moderating effect extends to an objectively assessed disease outcome. Being able to identify persons who are most likely to benefit from social support could play an important role in the design and application of future support interventions.

Acknowledgments

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Preparation of this manuscript was supported by grants from the National Center for Complementary and Integrative Health (AT006694), the National Institute of Allergy and Infectious Diseases (AI066367), the National Heart, Lung, and Blood Institute (HL65111, HL65112), and the National Institute of Mental Health (R01 MH50429); supplementary support was provided by the National Institutes of Health to the University of Pittsburgh Clinical and Translational Science Institute (UL1 RR024153, UL1 TR0005).

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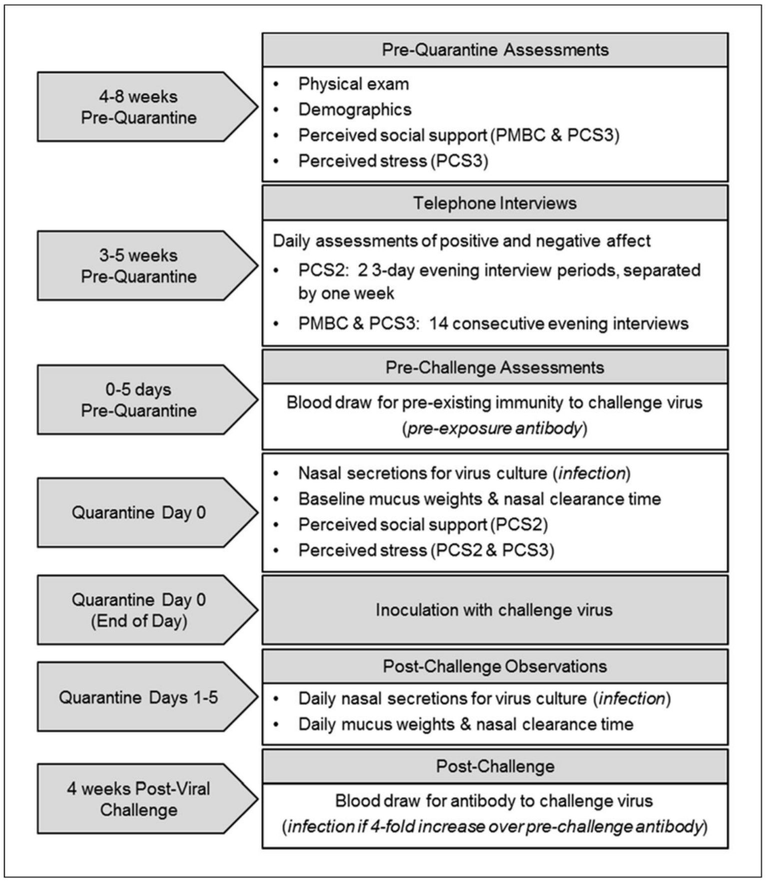

Figure 1.

Temporal sequence of study activities

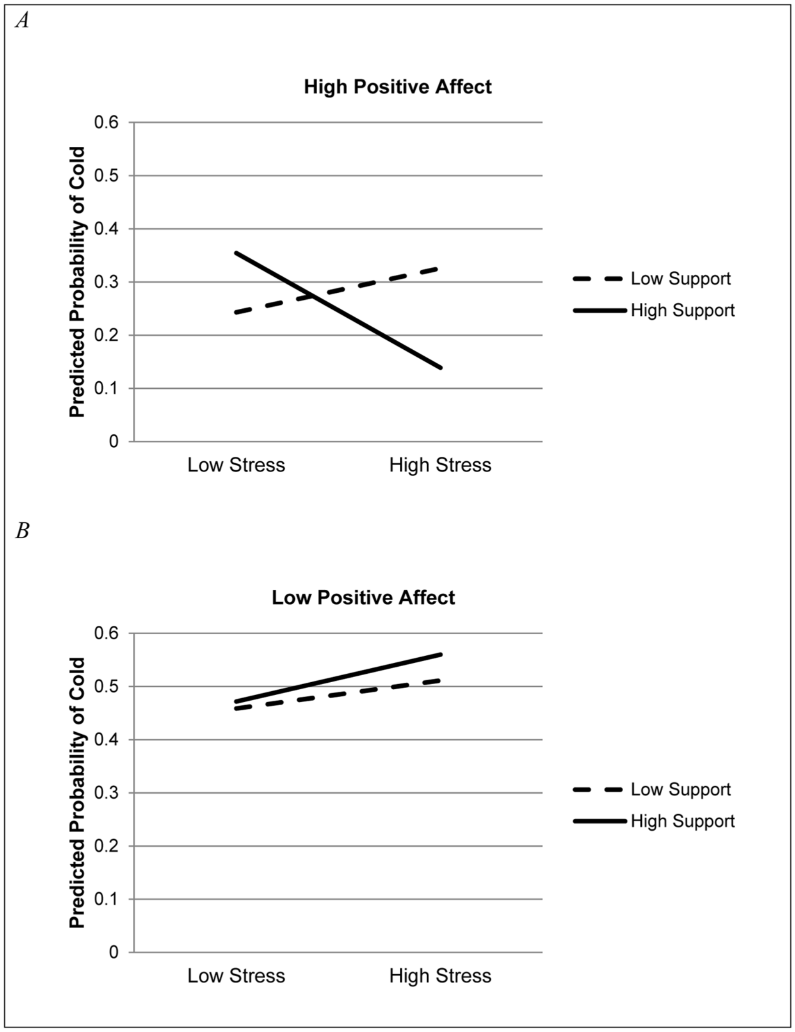

Figure 2.

Moderating effect of perceived stress on the association of perceived social support with cold risk at (*A*) high and (*B*) low trait levels of positive affect. High and low values are plotted at +1 standard deviation (SD) and −1 SD of the relevant variable mean.

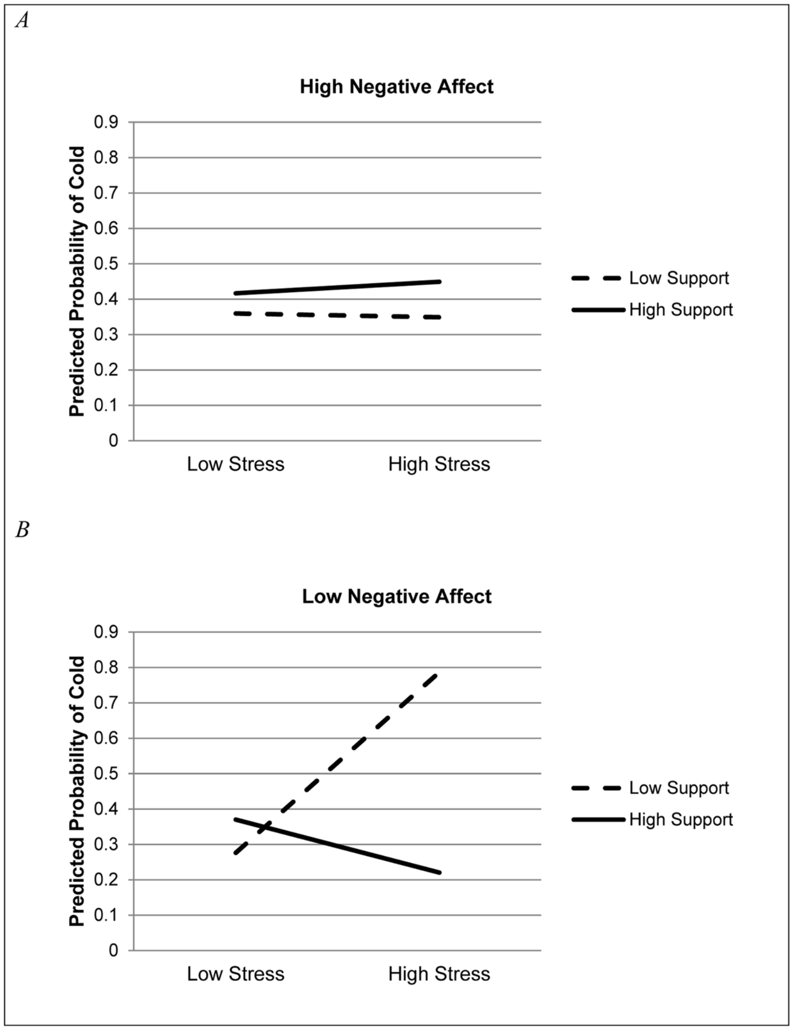

Figure 3.

Moderating effect of perceived stress on the association of perceived social support with cold risk at (*A*) high and (*B*) low trait levels of negative affect. High and low values are plotted at +1 standard deviation (SD) and −1 SD of the relevant variable mean.

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Table 1

Intercorrelations Among Study Variables

		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1.	Age	-																
2.	Sex	.00	-															
3.	Race	−.11**	.02	-														
4.	PCS2	−.20***	.07*	.07*	-													
5.	PCS3	−.05	−.09	.03	−.63***	-												
6.	RV23	−.02	−.01	−.02	.45***	−.28***	-											
7.	Ab ≥ 4	.11**	.05	−.10**	.22***	−.23***	.10**	-										
8.	BMI	.30***	.08*	−.21***	−.14***	.03	−.04	.05	-									
9.	Spring	−.04	.01	.12**	.13***	−.18***	−.06	.01	−.07†	-								
10.	Summer	−.001	.01	.00	−.24***	.38***	−.20***	−.14***	−.01	−.44***	-							
11.	Fall	.14***	−.002	−.15***	.03	−.31***	.17***	.13***	.08*	−.43***	−.22***	-						
12.	< HS	.04	−.03	−.18***	.04	−.05	.01	.07†	.05	−.01	−.08*	.10**	-					
13.	< 2yr	−.05	−.003	−.08*	.05	−.04	.03	.03	.05	−.01	.01	.01	−.40***	-				
14.	Assoc	−.05	.01	.10**	.02	.06	.02	−.01	−.02	−.01	.05	−.11**	−.31***	−.33***	-			
15.	PSS	−.03	.04	−.03	.16***	−.21***	.08*	.07†	−.01	−.01	−.06	.05	.05	.00	−.05	-		
16.	PA	.21***	.02	−.08*	−.10**	.05	−.01	.06	.09*	−.01	.02	.02	.05	−.04	−.01	−.39***	-	
17.	NA	−.05	.04	.03	.002	−.06	.05	−.08*	−.06	−.03	−.003	.03	−.03	−.04	−.02	.40***	−.42***	-
18.	ISEL	−.12**	.11**	.07†	.07†	−.03	.05	−.05	−.03	−.03	−.04	.04	.02	−.05	.00	−.35***	.27***	−.16***

† $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Age: participant age in years (continuous). Sex: female = 1; male = 0. Race: white = 1; nonwhite = 0. PCS2: participant in Pittsburgh Cold Study 2 = 1; all others = 0. PCS3: participant in Pittsburgh Cold Study 3 = 1; all others = 0. RV23: exposed to rhinovirus (RV) 23 = 1; exposed to RV39 = 0. Ab > 4: pre-exposure antibody (Ab) to challenge virus ≥ 4 = 1; pre-exposure Ab < 4 = 0. BMI: body mass index (kg/m^2; continuous). Spring: month of exposure in Spring = 1; all others = 0. Summer: month of exposure in Summer = 1; all others = 0. Fall: month of exposure in Fall = 1; all others = 0. < HS: highest level of education high school or less = 1; all others = 0. < 2 yr: highest level of education less than 2 years of college without degree = 1; all others = 0. Assoc: highest level of education at least 2 years of college with associate's degree = 1; all others = 0. PSS: Perceived Stress Scale score (continuous). PA: positive affect (continuous). NA: negative affect (continuous). ISEL: Interpersonal Support Evaluation List score (continuous).

Table 2

Results of Logistic Regression Analyses Examining the Moderating Effect of Trait Affect on the Stress-Buffering Effect of Social Support on Cold Risk

	Model 1			Model 2			Model 3		
	B	**SE**	***P***	***B***	**SE**	***p***	***B***	**SE**	***p***
Support x Stress x Trait PA	−.001	.000	.043	−.001	.000	.018	−.001	.000	.020
	$\chi^2(1) = 4.79$, $p = .029$								
Support x Stress x Trait NA	.010	.005	.031	.010	.005	.041	.010	.005	.043
	$\chi^2(1) = 5.42$, $p = .020$								

PA = positive affect. NA = negative affect. SE = standard error. χ^2 = goodness of fit test indicating the improvement in model fit with the addition of the 3-way interaction. Model 1 includes the main effects of perceived stress, social support, and PA/NA, all 2-way interactions (Support x Stress, Affect x Stress, Support x Affect), and the 3-way Support x Stress x Affect interaction. Model 2 = Model 1 + pre-challenge antibody level, virus, season of the year, study, and body mass index. Model 3 = Model 2 + age, sex, race, and educational attainment.

Table 3

Results of Logistic Regression Analyses Examining the Support x Stress Effect on Infection and Colds Among Infected Participants at High (+1 SD) and Low (−1 SD) Trait Positive and Negative Affect.

	Infection (n = 694)			Colds Among Infected (n = 524)		
	B	**SE**	***p***	***B***	**SE**	***p***
Support x Stress x PA	0.000	0.000	.650	−.001	.000	.021
High PA: Support x Stress				−.008	.003	.026
Low PA: Support x Stress				.001	.003	.722
Support x Stress x NA	.009	.005	.079	.012	.006	.051
High NA: Support x Stress				−.003	.004	.415
Low NA: Support x Stress				−.009	.004	.028

PA = positive affect. NA = negative affect. SE = standard error. All analyses control for study, virus type, pre-challenge antibody level, body mass index, season of the year, age, sex, race, and educational attainment. Models include the main effects of perceived stress, perceived social support, and trait affect, all 2-way interactions (i.e., Support x Stress, Stress x Affect, Support x Affect), and the 3-way Support x Stress x Affect interaction. Support x Stress effects at high and low PA and NA, respectively, are tested at +1 standard deviation (SD) and −1 SD of the relevant mean.