Positive Emotional Style Predicts Resistance to Illness After Experimental Exposure to Rhinovirus or Influenza A Virus

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: In an earlier study, positive emotional style (PES) was associated with resistance to the common cold and a bias to underreport (relative to objective disease markers) symptom severity. This work did not control for social and cognitive factors closely associated with PES. We replicate the original study using a different virus and controls for these alternative explanations.

This is especially important because self-rated health has been found to predict illness and longevity above and beyond objective health measures such as physician ratings (reviewed in (11)).

A final issue is the potential importance of differentiating activated (e.g., enthusiastic, joyful) and nonactivated (e.g., calm, content) affect (e.g., (12,13)). Health researchers consider physiological arousal a primary pathway through which emotions may influence health (e.g., (14,15)). It is thus possible that the arousing nature of an emotion, not only its valence, contributes to its potential influence on health outcomes. This is especially relevant in that most measures of PES use primarily activated emotions.

In an earlier study of 334 healthy adult volunteers experimentally exposed to one of two rhinoviruses (16), we reported that higher levels of undifferentiated PES were prospectively associated with a lower susceptibility to developing a common cold (diagnosed through objective markers of illness). In an additional analysis, we also found that those high in PES reported fewer symptoms of illness than one would expect from objective markers of their disease. The association between PES and colds was *independent* of negative emotional style (NES). However, these results are subject to the alternative explanations discussed previously: the measures of positive emotions may themselves be markers of associated cognitive and social dispositions such as extraversion, self-esteem, purpose, personal control, and optimism or may have been merely tapping self-reported health.

This article describes a replication of the earlier study with the intent of establishing the reliability and generali ability of reported associations. We do this by exposing subjects to either a rhinovirus (like in the earlier study) or an influen a virus that causes a common cold-like illness. We address the issue of possible (third) spurious factors that may influence both affect and health by including controls for the potential influence of NES, optimism, mastery, purpose, self-esteem, and extraversion. The possibility that measures of positive affect may actually be markers of self-reported (perceived) health is addressed by controlling for self-reported health using a measure that was previously associated with morbidity and mortality. Finally, we also assess whether the effects of PES are attributable to activated affect, nonactivated affect, or both with the hope of providing insight into how positive affect might influence health outcomes.

METHODS

After we assessed emotional styles, demographics, personality characteristics, self-reported health, and virus-specific antibody levels, volunteers were quarantined in separate rooms, exposed to either a rhinoviruses (RV) or influen a virus and followed for 5 (for RV) or 6 (for influen a virus) days to assess infection and signs and symptoms of illness.

Data were collected between 2000 and 2004. The subjects were 95 men and 98 women aged 21 to 55 years (mean = 37.3, standard deviation [SD] ± 8.8) who responded to advertisements and were judgded to

[kilograms]/height [meters^2]), race (white, black, other), sex, virus type (influ-
en a or RV39), and season of exposure (Spring, Summer, Autumn, Winter).

The seven-item Mastery Scale (20) was used to assess the extent to which one feels as though they manifest personal mastery over important life outcomes. The 10-item Life Orientation Test-R (21) was used to assess dispositional optimism; the four-item version of the Rosenberg Self-esteem Scale (22) to assess self-esteem; and the six-item Life Engagement Test (23) was used to assess the extent to which a person is purposefully engaged in the current activities of life. On all four scales, respondents indicated how much they agreed or disagreed with self-descriptive sentences. No timeframe or referent periods were used. For all the scales, the appropriate items were reversed and the scale scores were summed. The internal reliabilities were 0.72 for mastery, 0.78 for optimism, 0.8ism,r4miabilit.osr4miabilit.osr4miabilit9370(247(tQmiabily2447(used.)-447(30T [(w(30T247(asverse30T 32(wie30T394(th30

the expected mean differences across PES tertiles, a significant association was found only for calm (b = −0.08 ± 0.03, $p < .04$) with well-being (b = −0.05 ± 0.03, $p < .09$) approaching significance. Vigor, however, was not associated with the residuali ed symptom score ($p < .26$).

DISCUSSION

Like in our earlier study, increased PES was associated with decreased verified illness rates. This was true after controlling for age, race, sex, years of education, prechallenge antibody level, BMI, season, virus type, and NES. The reproducibility of the association across the RV39 and Influen a Texas/A (no interaction between PES and virus type; see Table 1) supports the generali ability of the effect and expands on the previous report in which similar results were found for RV23 and RV39. In contrast, NES did not predict verified colds and there was no support for the hypothesis that PES may be beneficial because it lessens or ameliorates the effect of NES (no PES-by-NES interaction).

That PES was not associated with infection but was associated with the expression of signs and symptoms of illness among infected people suggests that the release or synthesis of inflammatory mediators such as proinflammatory cytokines, histamine, or bradykinins responsible for the signs and symptoms of illness may mediate the relation between PES and colds (33). In fact, we found evidence consistent with IL-6 being the link between PES and colds in our previous study (33). However, although we do not report the data here, neither IL-6 nor cortisol (which regulates IL-6 release) plays a mediating role in these data. Even so, we are reluctant to treat these data as a disconfirmation of mediation because the current study has substantially less statistical power ($N = 193$) than the earlier study ($N = 334$). There are other possible mediators. For example, positive emotions might have their influence through biological processes (e.g., release of oxytocin (34)) that are different than those associated with negative emotions and stress.

Two of the PES component subscales (vigor and well-being) showed associations with verified disease similar to the total PES, whereas the third (calm) was not significantly associated, although the direction of the association was upheld. This suggests that the association of PES and colds may primarily reflect activated positive affect. However, subscales with more items and a broader representation of the different types of positive emotion are essential to verifying this association.

The failure of NES to predict colds is consistent with our previous work. Although we have twice found that *state* negative affect predicts greater disease susceptibility (35,36), our two attempts to predict colds from NES (also called neuroticism or negative affectivity) both found no associations (16,37). These results are also consistent with similar work in risk for cardiovascular disease that indicated NES predicted angina (based on self-reported symptoms) but not risk for verified cardiovascular disease (38).

Also consistent with our earlier work (16), PES was associated with reporting fewer symptoms than expected given objective markers of disease. In this case, higher PES might result in more positive interpretations of ambiguous sensations. As found before (35,37 39), NES was also associated with a bias in symptom reporting with increased scores associated with increased symptom reports. What was striking here is that the PES effect was larger than and independent of NES. In contrast, the NES effect was substantially decreased (and no longer significant) when PES was added to the equation. These data raise the question of whether the existing literature on NES and the reporting of unfounded symptoms might actually be explicable in terms of PES. That is, feeling fewer positive emotions may be more important than feeling more negative ones in predicting self-reported symptoms. When we looked at the role of the separate PES subscales, the effect was primarily driven by calm with well-being playing a lesser role, indicating that unactivated as well as activated positive affect play a role in this association.

The evidence we report for the associations of trait affectivity with both objective illness and symptom bias provides strong support for the independence and importance of PES. It is striking that studies of the roles of negative emotional styles such as anger, anxiety, and depression in health do not control for the possible role of correlated positive emotions. Take depression, for example. Depression is recogni ed as a risk factor for all-cause mortality, cardiovascular mortality, and recurrence of myocardial infarction (reviews in (40,41)). We think of depression as a marker of negative emotions. However, clinical depression is characteri ed by both high negative affect and low positive affect (42). In fact, in studies that have created separate scales from positive and negative items of the Center for Epidemiological Studies of Depression Scale, positive affect predicted survival (43) and the incidence of stroke (2), whereas negative affect did not predict in either case. Hence, we need to take more seriously the possibility that PES is a major player in disease risk, even in situations that we have attributed in the past to NES.

A major purpose of this study was to see if the associations between PES and both colds and symptoms were retained when we controlled for social and cognitive dispositions associated with PES, including optimism, extraversion, mastery, purpose, and self-esteem. These variables were proposed as being responsible for spurious associations between PES and health, in which they act as causal factors driving both greater PES and better health (1). These factors were, in fact, moderately correlated with PES. However, adding them as control variables (covariates) had little impact on the associations between PES and the health outcomes. In short, it is the pure affect that accounts for these relationships.

Finally, we wanted to address whether the PES illness associations could be attributed to self-rated health, an established predictor of morbidity and mortality. Here we controlled for self-rated health using a measure used widely in epidemiologic studies and found that PES still predicted illness and symptom reporting biases. Moreover, as mentioned

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