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Positive Emotion and Health: Going Beyond the Negative

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This study examined the relationships between positive emotions and health. Two positive emotions were considered, hope and curiosity, in conjunction with 3 physician-diagnosed disease outcomes: hypertension, diabetes mellitus, and respiratory tract infections. Medical data were abstracted over a 2-year period from 1,041 patient records from a multispecialty medical practice, and emotions were assessed through a mailed questionnaire. Across 3 disease outcomes, higher levels of hope were associated with a decreased likelihood of having or developing a disease. Higher levels of curiosity were also associated with decreased likelihood of hypertension and diabetes mellitus. Results suggest that positive emotion may play a protective role in the development of disease.

Keywords: positive emotion, hope, curiosity, disease outcomes

Much past work in health psychology has emphasized risk factors rather than resilience or protective factors when examining health outcomes. Numerous studies have found that negative emotions (anger, anxiety, depression) are associated with morbidity and mortality from a range of chronic illnesses, from cardiovascular disease (e.g., Barefoot et al., 2000; Kubzansky & Kawachi, 2000) to diabetes (Lustman, Frank, & McGill, 1991) to asthma (Friedman & Booth-Kewley, 1987). Much less is known about positive emotions and health. Some research has considered optimism and positive engagement as important protective factors in health and well being (see Ryff & Singer, 1998), which may suggest the importance of related positive emotions. In this study, we explored the role of two positive emotions in relation to specific disease outcomes and hypothesized that they may protect against poor health outcomes.

Recent epidemiological evidence has suggested that negative emotions may play an important role in the development of a variety of diseases, such as diabetes (Carnethon, Kinder, Fair, Stafford, & Fortmann, 2003) and hypertension (Everson, Goldberg, Kaplan, Julkunen, & Salonen, 1998; Jonas, Franks, & Ingram, 1997). For example, Jonas et al. (1997) found that high levels of anxiety were associated with two to three times greater risk of hypertension in Whites and Blacks, relative to their less anxious counterparts. Models of emotion and health have been developed to understand these associations and have primarily considered mechanisms that might link negative emotion to poor health. Such models identify both direct pathways that involve physiological activation and indirect pathways that involve behavior, cognition, and coping resources. A variety of physiological effects have been proposed (varying somewhat with the specific emotion under study), including alterations in the electric stability of the heart, chronic sympathetic nervous system activation, catecholamine release, dysregulation of the hypothalamic–pituitary–adrenal axis, serotonergic dysregulation, and endothelial dysfunction. Behaviors that are motivated by negative emotion can also have immediate and/or long-term effects on physiology and health. Chronically high levels of negative emotions, like anxiety, anger, and depression, are associated with adverse health behaviors, such as smoking, excessive alcohol consumption, greater body mass, and lower physical activity (Kawachi, Sparrow, Spiro, Vokonas, & Weiss, 1996; Kubzansky et al., 1997; Spielberger & Jacobs, 1982). Moreover, cognitions concerning health can frequently be influenced by emotion and may affect symptom perception, illness representation or beliefs, and behavioral responses or coping (see Mayne, 2001, for a review). For example, there is some evidence that individuals with greater emotional distress seek health care more frequently than their nondistressed counterparts for a variety of medical conditions, including arthritis (Vali & Walkup, 1998), irritable bowel syndrome (Drossman, 1999), and psoriasis (Scharloo et al., 2000).

Evidence of an association between positive emotion and health is far more limited. As a result, specific physiological, behavioral, or cognitive mechanisms that may link positive emotions to health have not yet been carefully explored. However, increasing evidence shows that positive emotions may protect health. Studies

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have found a relationship between positive affect and physiological changes linked to better immune functioning (Futterman, Kemeny, Shapiro, & Fahey, 1994). Similarly, enhanced immune function is associated with decreased susceptibility to infectious disease. Cohen, Doyle, Turner, Alper, and Skoner (2003) found that the tendency to experience positive emotional styles was associated with greater resistance to developing a common cold. The subscales of a questionnaire measure of positive emotion styles consisted of items measuring feelings of vigor, calm, and well-being and were associated with better health practices, as well as lower basal levels of epinephrine, norepinephrine, and cortisol. Further, Cohen et al. noted that the similarity of the association across two types of cold viruses suggests a biological generality for the effect. Other research has found strong associations between positive emotion experiences and longevity. In an analysis of autobiographies written by Catholic nuns, Danner, Snowden, and Friesen (2001) found that nuns whose writing contained less positive emotional content at age 22 were at 2.5 times greater risk of premature mortality than those whose writing contained strongly positive emotional content over six decades of follow-up. In the present study, we examined several positive emotions and their possible links with specific health outcomes.

Much of the research on positive states of mind and health has blurred distinctions between positive emotion and other types of positive psychological factors, such as optimism (cf. Salovey, Detweiler, Steward, & Rothman, 2000). In fact, there is little agreement about what may be considered a positive emotion. Prior emotion theories have generally failed to clearly define positive emotions, which tend to be more diffuse than negative emotions (Fredrickson, 1998). The broaden-and-build model of emotion identifies four positive emotion families—joy, interest, contentment, and love—and argues that within emotion families, a variety of affective states may be characterized by a common theme as well as variations on that theme (Fredrickson, 1998). Although not every positive state of mind should be considered a positive emotion, at this early stage of understanding, a somewhat broad definition of positive emotion may be helpful. Two potentially health-relevant emotions that have emerged in this literature are hope and curiosity, and on the basis of their conceptual definitions, both may be fairly considered within the emotion family of *interest*. Emotions in this family are associated with a sense of challenge and intrinsic motivation, and they may offer novelty, change or a sense of possibility, and a tendency toward exploration (cf. Fredrickson, 1998).

Emotion theorists have suggested that hope has the emotional features of being hard to control and nearly universal (see Averill, Catlin, & Chon, 1990). It motivates action and affects thoughts and behaviors (Gottschalk, 1985; Scioli et al., 1997). Scioli et al. (1997) suggested that hope is an emotion that encompasses optimism and other positive points of view.[1] Similarly, others have defined hope as a forward-looking emotion characterized by positive future expectations and the sense that one is likely to be able to meet situational demands (Ellsworth & Smith, 1988; Smith, Haynes, Lazarus, & Pope, 1993). According to the broaden-and-build model of positive emotion, hope may be viewed as an emotion that enables individuals to broaden their momentary thought–action repertoires (Fredrickson, 1998). This broadening of response can in turn build a variety of personal resources that can be accessed at a later time.

There is some evidence to support a positive link between hope and health outcomes. Most studies of hope have focused on assessing the value of hope in the face of life-threatening illnesses, such as cancer. In a review of studies on hope and illness, Gottschalk (1985) cited research that found a significant correlation between hope scores and survival time for patients with various forms of metastatic cancers. While few studies have examined the experience of hope and the development of disease, Scioli et al. (1997) conducted a prospective study of hope, optimism, and health and found that higher hope scores were correlated with reduced frequency and severity of illness. Hope has been related to other positive health indicators, such as quality of life (Rustoen & Wiklund, 2000) and mental health (Brackney & Westman, 1992; Nunn, 1996). Conversely, hopelessness was a significant predictor of disease-specific mortality as well as all-cause mortality in a large sample of Finnish men who had been treated for cancer or heart attacks (Everson et al., 1996).

Prior research suggests another positive emotion that may have salutary health effects. Curiosity has been defined as an affective state (or trait), closely linked to interest, that is related to wanting to investigate, to learn, and to incorporate new experiences. More cognitively oriented theorists have also suggested that curiosity is characterized by a set of hypothetical mechanisms that serve to orient or attract an organism to novel stimuli (e.g., Swan & Carmelli, 1996). Measures of curiosity primarily capture the extent to which individuals are engaged in their social environment and willing to explore novel stimuli.

Little is known about the relationship between curiosity and health, although there are some suggestions of possible links. In one prospective study, Swan and Carmelli (1996) found a relationship between curiosity in older men and women and subsequent survival over a 5-year period. Older adults who were more curious were at 30% decreased risk of dying during the study period, relative to less curious adults. Other research has suggested that older adults who display curious engagement with their environment, through hobbies or other activities, live longer and are less likely to develop degenerative diseases of the central nervous system (Silvia, 2001). Curiosity might sustain the health of the nervous system because it engages the person in dynamic construction and organization of cognition (Swan & Cormelli, 1996). There is much research to support the claim that curiosity creates more efficient seeking, learning, and organization of knowledge (e.g., Reeve, 1996; Schiefele, Krapp, & Winteler, 1992). Similarly, the broaden-and-build model suggests that high levels of curiosity should lead to accumulations of knowledge and competence that serve as resources that may facilitate growth and adjustment to stress and may reduce the risk of adverse health outcomes.

In the present investigation, we examined the effects of positive emotion on three physician-diagnosed health outcomes: hyperten-

[1] More cognitive definitions characterize hope as a way of thinking that is tied to goal pursuits, with a focus on agency and planning (cf. Snyder et al., 1991). Although the decision about whether to characterize hope as an emotion or as a cognitive belief has been somewhat controversial, a substantial tradition of research characterizes hope as an emotion (Ellsworth & Smith, 1988; Gottschalk, 1985; Lazarus, 1991; Scioli et al., 1997; Zautra, 2003). Our research is based in this tradition, and the hope measure we used in this research was explicitly conceptualized and developed as a measure of emotion by Ellsworth and Smith (1988).

sion (HT), diabetes mellitus (DM), and respiratory tract infections (RTIs). We did not predict that emotions would have disease-specific effects, but rather hypothesized more general effects on health. Thus, we expected to find links between emotions and multiple health outcomes. In this study, we focused on health outcomes that have demonstrated links with other emotions. In addition, for practical purposes, the three outcomes in the present study were chosen because they represent three disease categories commonly experienced by older adults. Generally, little research has examined relationships of either hope or curiosity with major health outcomes. Further, many of the initial studies linking positive emotional states to health suffer from the methodological limitation of relying on self-reports of physical symptoms, which may be subject to recall bias. A strength of the present study is that it avoids possible confounding by using self-report methodology to assess emotions and assessing health outcomes with physician diagnosis.

Overview

We examined whether positive emotion may protect against the specific disease outcomes of HT, DM, and RTIs. We measured two emotions, hope and curiosity, through a mailed questionnaire. Disease outcomes were assessed from data abstracted from patient records obtained from a multispecialty, multigroup medical practice over a 2-year period. After controlling for relevant factors, we examined the hypothesis that those with higher levels of positive emotion would be less likely to develop these diseases.

Method

Sample and Procedure

We randomly selected 5,500 patients ages 55–69 years[2] from the database of a multispecialty practice caring for 180,000 adults in urban and suburban settings. We contacted each patient's primary care physician and requested permission to recruit the patient. Several of the physicians did not grant consent, so from the original pool of potential patients, 4,027 received the mailed questionnaire. All patients had HMO-type coverage and had relatively low copayments for office visits. There was no financial incentive for study participation. A total of 1,041 patients completed the questionnaire and gave permission to access their records, yielding a response rate of 27%. This response rate is typical of surveys that do not include a financial incentive and do not have funding to administer repeated follow-up reminders (Tedin & Hofstetter, 1982). There were few differences in response rates across gender and age. The distribution of men and women was similar to that of the overall practice patient base of 55% women and 45% men. The mean age was 61.8 years ($SD = 4.5$ years, range = 55–70 years).

The questionnaire assessed emotions, health behaviors, and demographic information. More than a year after the questionnaire was returned, data were abstracted from the computerized medical record system, focusing on the year before the administration of the questionnaire (prebaseline) and the year after the administration of the questionnaire (postbaseline). Medical record information was recorded at each outpatient visit by the examining clinician, who was required to enter diagnoses using the International Classification of Diseases (9th ed., clinical modification; ICD-9-CM, 2002) codes. Records were 99.9% complete.

Measures

Emotional traits. Measures of hope and curiosity were derived from two established scales, trait hope and trait curiosity. A measure of trait hope was obtained by asking participants to respond to four items describing whether they generally felt hopeful, challenged, confident, or expectant. These items were derived from emotion scales developed by Ellsworth and Smith (1988) and have been used in numerous studies of emotion (e.g., Ellsworth & Smith, 1988; Smith & Ellsworth, 1987). In the present study, this scale had an alpha level of .69. Participants also completed the Trait Curiosity subscale of the Spielberger State–Trait Personality Inventory (Spielberger, 1998), which has demonstrated good psychometric properties. A measure of trait curiosity was obtained by asking participants to respond to 10 items describing the degree to which individuals generally felt they were consistently engaged in their social environment (e.g., whether they felt inquisitive). Items were scored on a Likert-type scale. In the present study, this scale had an internal consistency reliability coefficient of $\alpha = .86$. Hope and curiosity were correlated ($r = .70$, $p < .01$), suggesting that they share similar features and may come from the same family of positive emotion.

Two negative emotions were also assessed in this study: trait anxiety and trait anger. Each of these emotions was assessed using the trait measures of the State–Trait Personality Inventory. Trait anxiety reflects stable individual differences in the frequency and intensity with which anxiety states have been manifested in the past and in the probability that anxiety will be experienced in the future (Spielberger, 1998). The Anxiety subscale included 10 items and had an internal consistency reliability coefficient of $\alpha = .84$. Trait anger is defined as the disposition to perceive situations as annoying or frustrating and the tendency to respond to such situations with more frequent elevations in state anger (Spielberger, 1998). The Anger subscale included 10 items and had an internal consistency reliability coefficient of $\alpha = .81$.

Health behaviors and demographics. We obtained self-report measures of smoking status and alcohol consumption (Cheng, Kawachi, Coakley, Schwartz, & Colditz, 2000), as well as physical activity (Chasan-Taber et al., 1996), using standardized and validated scales. We also measured demographic information on gender and age, as well as subjective socioeconomic status (SES), for which we used a ladder measure (see Ostrove, Adler, Kuppermann, & Washington, 2000). This is a measure that asks people to indicate their relative social standing in relation to other people in the United States. Participants were given a drawing of a ladder with 10 rungs described as representing where people stand in U.S. society. At the top of the ladder are the people who are best off in terms of money, education, and jobs, and at the bottom are the people who are worst off. Participants were asked to place an X on the rung that best represented where they thought they stood. Higher numbers indicate higher perceived standing. Objective measures of SES (e.g., income, occupation, education) were not available in the data set.

Assessment of health outcomes. We chose our health outcomes on the basis of the frequencies of diagnoses available in the sample over the 2-year period and on the basis of the prior literature demonstrating evidence of an association between health and emotion. Previous work has suggested links between negative emotion and three commonly occurring health outcomes in our sample: HT (e.g., Jonas et al., 1997), RTIs (e.g., Cohen, Doyle, Skoner, & Fireman, 1995), and DM (e.g., Carnethon, Kinder, Fair, Stafford, & Fortmann, 2003). Other evidence has shown links between negative emotion and other outcomes, such as musculoskeletal pain (e.g., Carroll, Cassidy, & Cote, 2000) or cancer (Shekelle et al., 1981), which we considered including in the present study. However, for some diseases we did not have a sufficient number of cases to power our analyses, and others (like cancer) were highly heterogeneous and had very few new cases during the study period.

[2] Age of participants was restricted because the original study for which these data were collected was designed to examine coronary heart disease outcomes.

Thus, for this study, relevant diagnoses were grouped into three broad classifications: HT, DM, and RTIs. Two physicians, in concordance, established these domains of classification prior to data analysis. Physicians were unaware of patient status on the emotion variables of interest. All diagnoses were identifiable in patient records through ICD-9-CM codes. The physicians reviewed the list of diagnoses occurring in the 2-year study period and assigned relevant diagnoses (on the basis of their ICD-9-CM codes and diagnostic criteria) to the three outcomes of interest: HT, DM, and RTIs. The ICD-9-CM diagnostic codes for each health outcome are 250 for diabetes, 465 for acute respiratory infections, 466 for acute bronchitis, 486 for pneumonia, 490 for bronchitis, and 401 for hypertension. Because the physicians worked in concert to develop these categories, interrater reliability information is unavailable. HT and DM were coded for prevalence and incidence. Prevalence of HT and DM was coded *yes* or *no* according to whether patients received a diagnosis in the 2-year time frame. Incidence of HT and DM was coded *yes* or *no* according to whether patients received a diagnosis in the year after baseline but did not have the disease in the year prior to emotion assessment (prebaseline). As listed above, the RTIs included six diagnoses representing acute illnesses of the respiratory tract. RTIs are different from HT and DM in that they are not chronic diseases; individuals may have received separate diagnoses for different RTIs in our 2-year time frame. The outcome variable, therefore, reflects a count of the number of times a given patient received such a diagnosis.

Statistical Analyses

Our primary research question concerned whether levels of hope and curiosity were related to risk of three disease outcomes. The data indicated that few patients were diagnosed with a RTI more than once. To account for this skewed distribution, we used Poisson regression models to examine this outcome. These models assume a Poisson distribution for the dependent variable but can include multiple covariates, and parameter estimates can be interpreted in a manner similar to standard linear regression (Pagano & Gauvreau, 1993). Thus, we used logistic regression analysis to predict the two dichotomous outcomes (HT and DM) and Poisson regression to predict RTIs. Initial regressions were modeled controlling for age only, and then full multivariate models controlled for age, gender, SES, and health-related behaviors, including smoking, exercise, and alcohol intake. Primary analyses considered the emotion measures as continuous variables. To consider the possibility of threshold effects, we also created tertiles of each emotion measure, based on the distribution of scores in this sample.

Results

Descriptive Statistics

We examined the distribution of potential risk factors for disease across levels of hope and curiosity (see Table 1). Age was not associated with either emotion, and more men than women reported having high levels of curiosity (although this difference was not significant). Subjective SES was positively associated with both emotions such that the higher the level of subjective SES, the higher the hope and curiosity scores.

Associations of Hope and Curiosity With Disease Outcomes

HT. Hope was associated with incident cases of HT (although this association did not reach statistical significance), and curiosity was strongly associated with incident cases of HT, indicating that both of these emotions may predict development of HT in Year 2 (see Table 2). In the multivariate model, the odds ratio (OR) for hope was 0.65 (95% confidence interval [CI] = 0.41–1.03, $p < .07$), indicating a 35% decrease in the odds of being diagnosed with HT for each one-unit increase in hope over the 1-year follow-up. The OR was 0.43 (95% CI = 0.26–0.70, $p < .01$) for curiosity, indicating that a one-unit increase in curiosity was associated with a 57% decreased likelihood of developing and being diagnosed with HT. Hope was also significantly inversely associated with having a diagnosis of HT (prevalence; OR = 0.62, 95% CI = 0.48–0.80, $p < .01$). The pattern of results was similar for curiosity with a 40% reduction in risk (OR = 0.59, 95% CI = 0.45–0.78, $p < .01$).

Using tertiles, we also considered the possibility of threshold effects. Patients with the highest hope scores were at a 48% decreased risk of being diagnosed with HT in Year 2 (OR = 0.52, 95% CI = 0.27–0.99, $p < .05$) compared with patients with the lowest scores. Results were similar and somewhat dramatic for curiosity (OR = 0.36, 95% CI = 0.18–0.71, $p < .01$) for patients with the highest scores of curiosity compared with patients with the lowest scores. This pattern was also evident for prevalence of cases of HT (see Table 2). Generally, the pattern of results sug-

Table 1
Distribution of Potential Risk Factors According to Levels of Hope and Curiosity (N = 1,041)

	Level of hope			Level of curiosity		
Risk factor	Low	Medium	High	Low	Medium	High
Age	61.8	61.7	61.7	62.0	61.9	61.5
Sex (% men)	46	45	44	44	44	46
SES (1–9)	5.8_a	6.7_b	7.1_c	5.9_a	6.6_b	7.1_c
Current smoker (%)	9.0	6.4	6.9	10.5_a	9.1_a	4.3_b
Activity level (METs per week)	18.9_a	28.4_b	33.1_b	22.8	21.4	33.5
Alcohol consumption (servings per week)	4.6_a	6.2_b	5.5_b	4.9_a	5.2_a	6.0_b

Note. Within levels of hope and within levels of curiosity, means with different subscripts differ significantly at $p < .05$. Differences based on age, socioeconomic status (SES), activity level, and alcohol consumption were tested using one-way analyses of variance; differences based on sex were tested with chi square analysis. MET = metabolic equivalent level.

Table 2
Association Between Positive Emotions, 2-Year Prevalence, and Incidence of Hypertension

	Prevalence[a]				Incidence[b]			
	Age only		Multivariate		Age only		Multivariate	
Emotion trait	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Continuous								
Hope	0.66**	0.52–0.83	0.62**	0.48–0.80	0.68	0.45–1.02	0.65	0.41–1.03
Curiosity	0.59**	0.46–0.75	0.59**	0.45–0.78	0.45**	0.29–0.69	0.43**	0.26–0.70
Tertiled								
Hope								
Low	1.00		1.00		1.00		1.00	
Moderate	0.76	0.54–1.07	0.74	0.52–1.06	0.63	0.34–1.17	0.58	0.30–1.12
High	0.56**	0.40–0.78	0.52**	0.36–0.76	0.53*	0.30–0.96	0.52*	0.27–0.99
Curiosity								
Low	1.00		1.00		1.00		1.00	
Moderate	0.74	0.54–1.01	0.73	0.52–1.01	0.60	0.35–1.04	0.62	0.35–1.11
High	0.56**	0.41–0.77	0.57**	0.40–0.80	0.38**	0.21–0.69	0.36**	0.18–0.71

Note. Continuous and tertiled multivariate models adjusted for age, gender, smoking, exercise, alcohol intake, and subjective socioeconomic status. OR = odds ratio; CI = confidence interval.
[a] Number of cases = 389. [b] Number of cases = 80.
* $p < .05$. ** $p < .01$.

gested a dose response rather than a clear threshold at which such effects may occur.

DM. Neither hope nor curiosity was associated with incidence of DM (see Table 3). Very few cases of new DM were reported in Year 2 ($n = 16$), which may have affected our power to see any effects. Hope was associated with ever having had a diagnosis of DM, and this association approached significance. The multivariate OR was 0.67 (95% CI = 0.44–1.00, $p = .05$). The pattern of results was similar for curiosity (multivariate OR = 0.62, 95% CI = 0.41–0.94, $p < .05$), suggesting that with each one-unit increase in curiosity, individuals were 38% less likely to have DM.

Using tertiles, we also considered the possibility of threshold effects. Although tertiles of hope and curiosity were not significantly associated with incident cases of DM, they were associated with prevalent DM. The OR of having DM was 0.52 (95% CI = 0.28–0.96, $p < .05$) for patients with the highest hope scores compared with patients with the lowest scores. The pattern of results was similar for curiosity (OR = 0.56, 95% CI = 0.32–0.97, $p < .05$) for patients with the highest scores of curiosity compared with patients with the lowest scores. The pattern of results, however, suggested a dose-response relationship between prevalent DM and hope, rather than a clear threshold at which such effects may occur.

Table 3
Association Between Positive Emotions, 2-Year Prevalence, and Incidence of Diabetes Mellitus

	Prevalence[a]				Incidence[b]			
	Age only		Multivariate		Age only		Multivariate	
Emotion trait	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Continuous								
Hope	0.57**	0.40–0.82	0.67	0.44–1.00	1.21	0.50–2.89	1.65	0.62–4.40
Curiosity	0.51**	0.36–0.74	0.62*	0.41–0.94	1.13	0.44–2.92	1.31	0.47–3.64
Tertiled								
Hope								
Low	1.00		1.00		1.00		1.00	
Moderate	0.64	0.38–1.07	0.77	0.44–1.35	1.74	0.48–6.24	1.82	0.46–7.31
High	0.38**	0.22–0.67	0.52*	0.28–0.96	0.96	0.24–3.90	1.41	0.31–6.31
Curiosity								
Low	1.00		1.00		1.00		1.00	
Moderate	0.52**	0.33–0.84	0.54*	0.33–0.90	1.32	0.37–4.72	1.43	0.38–5.31
High	0.44**	0.27–0.72	0.56*	0.32–0.97	1.26	0.35–4.50	1.48	0.36–6.03

Note. Continuous and tertiled multivariate models adjusted for age, gender, smoking, exercise, alcohol intake, and self-rated socioeconomic status. OR = odds ratio; CI = confidence interval.
[a] Number of cases = 115. [b] Number of cases = 16.
* $p < .05$. ** $p < .01$.

RTIs. In a model controlling for age, hope significantly predicted number of RTIs ($b = -0.24$, $SE = 0.09$, $p < .05$). In this model, people with higher levels of hope were less likely to have an RTI diagnosis. The addition of covariates somewhat attenuated the parameter estimate ($b = -0.16$, $SE = 0.11$, $p = .14$). No significant associations of curiosity with RTI were evident. We examined possible threshold effects with hope. Comparisons of high scorers on hope to low scorers in the multivariate model yielded similar, significant results ($b = -0.30$, $SE = 0.15$, $p < .05$). Examination of the tertile parameters did not strongly suggest the likelihood of a threshold effect. However, to further understand the nature of this relationship, we also modeled various higher order trends (quadratic and cubic). None of these models were significant, suggesting that curvilinear models did not provide a better fit for the data.

Negative emotions. Given that other research has suggested that negative emotions are risk factors for a variety of diseases, we considered whether our results might be a function of the relationship between positive and negative emotions. We compared the correlations between these scales and negative emotions. Two negative emotions were available in these data, anxiety and anger (both measured by the State–Trait Personality Inventory; Spielberger, 1998). Correlations were in the expected directions and were all significant ($p < .01$). The correlation between anxiety and hope was $r = -.57$ and between anger and hope was $r = -.17$. The correlation between anxiety and curiosity was $r = -.45$ and between anger and curiosity was $r = -.19$. We first examined whether anger and anxiety were independently associated with each disease outcome in models that did not include the positive emotions. Results were not significant for either incidence or prevalence of HT (for anger, OR = 1.32, 95% CI = 0.69–2.50, for incidence, and OR = 0.92, 95% CI = 0.80–2.50 for prevalence; for anxiety, OR = 1.40, 95% CI = 0.83–2.38, for incidence, and OR = 0.97, 95% CI = 0.71–1.32, for prevalence). Similarly, the results were not significant for incidence of DM (for anger, OR = 0.98, 95% CI = 0.26–3.77 for incidence, and OR = 1.69, 95% CI = 1.01–2.81, for prevalence; for anxiety, OR = 0.87, 95% CI = 0.25–3.00, for incidence, and OR = 1.29, 95% CI = 0.81–2.07, for prevalence). Anger but not anxiety predicted prevalence of DM. For incidence of RTIs, the results approached significance for anger and anxiety ($b = 0.26$, $SE = 0.14$, $p = .06$, for anger; $b = 0.23$, $SE = 0.12$, $p = .05$, for anxiety), suggesting that higher levels of anger and anxiety may be somewhat related to the development of RTIs. In addition, for each disease outcome, we added the two negative emotions (anxiety and anger) to the multivariate models with positive emotions to assess whether positive emotions had effects over and above those of negative emotions. Effects were largely unchanged, suggesting that our results cannot be attributed to the relationship of hope or curiosity with these negative emotions.

Discussion

Our results suggest a protective function of positive emotion for two indicators across multiple disease outcomes. Effects of both positive emotions (hope and curiosity) were maintained after controlling for a variety of potential confounders including health behaviors. The consistency of effects across diseases that involve different physiological systems (cardiovascular, metabolic, and respiratory) strongly suggests broad-based effects of positive emotion on health. Moreover, the prospective analyses suggest the possibility of a protective role for positive emotion in the development of disease.

Further, we did not find that the presence of positive emotion is equivalent to the absence of negative emotion. The relationships of negative emotion with our measures of hope and curiosity were in the expected directions, providing some evidence of the validity of these measures. However, when we considered health in relation to both negative and positive emotion, together in the same model and separately, we found that positive emotion was associated with health outcomes beyond the effects of negative emotion. There appears to be something uniquely protective about positive emotion. These results are consistent with research by Penninx et al. (2000) in which they found that the protective effects of emotional vitality for disability progression and mortality were not simply caused by the absence of depression, because protective health effects remained when emotionally vital women were compared with women who were emotionally vital and not depressed. Similarly, recent research by Cohen et al. (2003) found that the association of positive emotional states with susceptibility to colds was independent of negative emotional states.

This study provides evidence for an important association between positive emotion and health. What are the mechanisms that might explain this relationship? One mechanism underlying this relationship might be that the experience of positive affect bolsters the immune system directly. Various immune parameters have been shown to be susceptible to influence by affective states (Futterman et al., 1994; Stone, Cox, Valdimarsdottir, Jandorf, & Neale, 1987). Another possible mechanism for the influence of positive emotion on health outcomes may be increased attention to health-relevant information. Optimistic beliefs, for example, are linked to greater processing of health-risk information (Aspinwall & Brunhart, 1996). The broaden-and-build model (Fredrickson, 1998), one of the few theoretical models of positive emotion that has been proposed, may provide additional guidance to aid the identification of pathways from positive emotions to health. Emotions in the emotion family of *interest* have the capacity to broaden an individual's momentary thought–action tendencies and over time can build an individual's personal resources, such as increased social networks and knowledge. In this way, such positive emotions may facilitate growth as well as successful adaptation to ongoing demands. Further research will need to elucidate the precise mechanisms by which such emotions may influence health.

Research examining allostasis, which describes how individuals adapt to change while maintaining physiological systems within a normal range (Sterling & Eyer, 1988), also provides promising insights into the biological and neurobiological mechanisms that may mediate emotion influences on health. Recent work has suggested that cumulative stress may lead to wear and tear on the body because of the chronic over- or underactivity of allostatic systems to produce allostatic load (e.g., Seeman, Singer, Rowe, Horwitz, & McEwen, 1997). However, some evidence shows that positive emotions may speed internal homeostatic processes, specifically for cardiovascular functioning (Fredrickson & Levenson, 1998), and as a result, positive emotions may reduce stress on the cardiovascular system in the face of negative life events. Fredrickson and Levenson (1998) proposed the following sequence: Events arousing negative affect are approached with confidence that the

future will be better. Such an approach internally generates a positive emotional state that mutes the adverse effects of the prolonged arousal of negative emotion. Subsequent studies have found some support for this theory (e.g., Fredrickson, Mancuso, Branigan, & Tugade, 2000). Whether positive emotion may also initiate biological effects that are themselves health promoting is a plausible hypothesis that remains to be tested. Such effects would suggest that positive emotions are not simply stress buffers but have positive effects beyond stress (cf. Zautra, 2003).

This study is subject to a number of limitations. One limitation is that we had few incident cases of DM. It may be that the failure to find an association with emotion suggests that emotion does not play a role in the development of DM. However, power for this analysis was low, and evidence of a significant association with prevalent DM is suggestive. As a result, we argue that further studies are needed to evaluate this question more fully. The internal validity of this study is high. However, because of the low response rate to the survey, results should be interpreted cautiously. These data were originally collected as preliminary data for a study of anger and coronary heart disease. It is possible that physicians and patients agreed or declined to participate on the basis of their mood states or health status. However, given that participants did not know the current study's hypotheses concerning positive emotions when they agreed to complete the survey, it seems unlikely that such systematic bias would affect the findings reported here. Nonetheless, our survey's response rate (27%), although not atypical of surveys administered by mail, is low, and more research is needed to determine the generalizability of our results. Finally, although we measured physician diagnosis rather than symptom reporting, which eliminated some potential sources of error, it is possible that we may have captured a willingness to go to the doctor or a sensitivity to symptoms. HT, however, is symptom free, which, in combination with findings on incident HT, lends strength to the causal perspective of hope and curiosity leading to better health outcomes.

Positive emotion may play a variety of roles in protecting health. It may protect against current disease development and, in view of research that examines duration of survival from illness as an outcome, it may also be that positive emotion protects against progression of disease (e.g., Levy, Slade, Kunkel, & Kasl, 2002). It appears that positive emotions are more than simply the absence of the negative. Rather, they may initiate their own cascade of biological and behavioral effects, confer a broad-based resilience, and perhaps even promote health. The strength and consistency of our findings across widely different disease outcomes suggests the multiple possibilities for further research in this area.

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