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### **Positive Emotions and Health in Adulthood and Later Life**

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### **Abstract and Keywords**

Theoretical models and empirical evidence support an association between positive emotions and enhanced physical health. In this essay, we describe the current state of knowledge regarding the health significance of positive emotions in later life. We begin by exploring the contribution of lifespan theories of aging to emotion research. We then provide an overview of existing empirical evidence relevant to the role of positive emotions and adult health and well-being. We conclude with a discussion of how the integration of theoretical models and empirical findings can inform future research exploring the health effects of positive emotions across the lifespan.

Keywords: Aging, health, positive emotions, resilience

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Changes in physical, cognitive, and emotional functioning pervade the aging process. In contrast with the pattern of age-related declines in physical health, emotional well-being appears to be preserved with age. Efforts to uncover this “paradox” of aging have recently begun to identify possible mechanisms that may account for age differences in emotional experience (see Charles & Carstensen, 2009; Scheibe & Carstensen, 2010; Urry & Gross, 2010, for a review). In the following sections, we review lifespan theories of emotion, with specific attention to health implications for older adults. We then discuss how age-associated gains in positive emotions may support physical well-being in later life. In doing so, we summarize recent evidence on the biobehavioral mechanisms that may account for this relationship by focusing on the approaches, empirical findings, and methodological inconsistencies that exist in present literature. Finally, we delineate future new directions in emotional aging research.

### Age Differences in Emotional Well-Being

Although advanced age is marked by physical and cognitive decline, accumulating research suggests that affective well-being is maintained well into later life (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Charles, Reynolds, & Gatz, 2001; Charles, 2010; Charles & Carstensen, 2009). In fact, increased age is associated with improved emotion regulation and emotional stability (e.g., Carstensen et al., 2000; Charles et al., 2001; Charles, 2010). Both cross-sectional (Carstensen et al., 2000; Gross et al., 1997; Mroczek & Kolarz, 1998) and longitudinal studies (Charles et al., 2001; Costa et al., 1987; Griffin, Mroczek, & Spiro, 2006) substantiate this association and further reveal that reductions in negative emotional experience are accompanied by a greater frequency in positive emotions across age cohorts. Even individuals in their eighties enjoy high levels of positive emotions; it is not until the “terminal phase” of life that older adults exhibit a precipitous decline in affective (p. 116) well-being (Gerstorf et al., 2010). Although some evidence calls into question whether age-related shifts in subjective well-being are moderated by functional health constraints (Kunzmann, Little, & Smith, 2000), overall, the data suggest that positive emotions remain stable throughout adulthood.

Below, we describe two theories of emotional aging that provide distinct accounts of how positive emotions are maintained into adulthood. Socioemotional selectivity theory (Carstensen, Isaacowitz, & Charles, 1999) and dynamic integration theory (Labouvie-Vief, 2003) propose different explanations for the trajectory of emotional aging across the lifespan. Although empirical evidence provides general support for each of these theories, research has yet to identify the underlying mechanisms associated with the hypotheses proposed by each framework.

### Information Processing and the Positivity Effect

Socioemotional selectivity theory contends that time perception plays a key role in motivation, especially as it relates to goal selection and goal pursuit (Carstensen & Charles, 1998). When time horizons are perceived as expansive, as they often do in youth, goals focused on gaining knowledge and information are prioritized. Alternatively, as the end of life draws near and temporal horizons shrink, older adults begin to seek more emotionally satisfying experiences and avoid negative ones. Socioemotional selectivity theory points to the shift in motivation as contributing to older adults' tendency to prioritize positive over negative material. This developmental pattern, termed the “positivity effect,” is proposed to have implications for age-related changes in information processing systems, such as memory and attention (Carstensen & Mikels, 2005; Kensinger, Garoff-Eaton, & Scgacter, 2007).

### The Positivity Effect in Memory

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Growing evidence indicates that memory for emotional material, especially positive emotional material, is enhanced in older adults (Carstensen & Mikels, 2005). Studies of recall and recognition memory reveal that although older adults recall fewer images than younger adults, they recall more positive images as compared to negative images (Charles, Mather, & Carstensen, 2003). Furthermore, research on working memory suggests that older adults' memory performance is enhanced when they are asked to recall stimuli that are positive in valence (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005).

Consistent with laboratory findings, studies of autobiographical memory and mutual reminiscing also point to an age-related positivity bias. For example, one study found that when asked to recount personal experiences from over a decade prior, older adults tended to remember the past in a more positive light than originally reported (Kennedy, Mather, & Carstensen, 2004). Younger adults, on the other hand, remembered the past more negatively. This experience also holds during mutual reminiscing: older adults report more positive and fewer negative emotions when engaging in retrospective retelling of the personal past (Pasupathi & Carstensen, 2003).

Although this work illustrates older adults' selective memory for positive material, other research reveals that this may not always be the case. For example, a study comparing younger (18–31 years) and older (64–75 years) adults failed to find an aging bias in memory for emotionally toned words (Gruhn, Smith, & Baltes, 2005). In general, however, an association between advanced age and positively biased memory is documented across the literature (Murphy & Isaacowitz, 2008).

### The Positivity Effect in Attention

Studies of attention also provide evidence for the positivity effect. With advanced age, older adults selectively attend more to emotional information and exhibit a bias toward positive rather than negative stimuli. Dot-probe and eye-tracking studies of visual attention support this age-related positivity bias. For example, in a study of younger (18–24 years) and older (61–85 years) adults, Isaacowitz and colleagues (2006a) found that older individuals display a gaze pattern toward happy and away from sad faces, whereas younger adults showed no preference for happy faces, but looked away from sad faces. This same study demonstrated that older adults responded more quickly when dot probes replaced positive stimuli with negative stimuli. These results corroborate with findings from other visual attention studies showing that older adults tend to look away from emotionally negative faces (Isaacowitz, Wadlinger, Goren, & Wilson, 2006b; Mather & Carstensen, 2003).

Consistent with socioemotional selectivity theory, recent evidence suggests that positive attentional preferences may assist older adults in regulating their emotional experiences (Isaacowitz, Toner, Goren, & Wilson, 2008; Isaacowitz, Toner, & Neupert, 2009). In other words, focusing attention on positive stimuli helps to optimize affect (p. 117) as well as manage negative emotional experiences. Importantly, individual differences may influence attentional deployment. For instance, the ability to avoid negative stimuli may

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hinge on cognitive control. Whereas individuals without the necessary resources may be unable to successfully engage in regulatory strategies (Knight et al., 2007), those with good executive functioning are able to resist mood declines by displaying gaze preferences toward positive and away from negative faces when in a bad mood (Issacowitz et al., 2009).

### Neural Evidence of the Positivity Effect

Additional support for the positivity effect comes from functional magnetic resonance imaging (fMRI) studies exploring neural responses to emotional stimuli. Emerging research in this area reveals age-related changes in subcortical and cortical activation (Samanez-Larkin & Carstensen, 2011). For example, older adults (70–90 years) show greater amygdala activation in response to positive images than do younger adults (18–29 years) and relatively less activation when viewing negative images (Mather et al., 2004). Such changes in brain activation patterns may reflect underlying age-related shifts in emotion regulation and processing (Scheibe & Carstensen, 2010), which in turn serve to promote emotional well-being in later life.

### Cognitive Control

In contrast with socioemotional selectivity theory, which emphasizes goal selection as a key component in emotional preservation, dynamic integration theory (Labouvie-Vief, 2003) posits that developmental declines in cognitive resources may account for age differences in emotion regulation and well-being. Specifically, this theory proposes that affect regulation depends on two core elements: *optimization*, an unconscious, automatic process of enhancing affect, and *differentiation*, a complex, conscious process of incorporating one's own feelings and knowledge with the thoughts and feelings of others. Together, differentiation and optimization are hypothesized to promote optimal emotion regulation (see Labouvie-Vief et al., "The Dynamics of Cognitive-Emotional Integration: Complexity and Hedonics in Emotional Development" for details).

According to dynamic integration theory, diminishing executive functioning in older adults elicits a gradual shift from a more complex mode of emotion regulation (i.e., differentiation) to one favoring simplicity. In support of this prediction, a cross-sectional study comparing younger (15–29 years), middle-aged (30–59 years), and older adults (60–86 years) found that older individuals tended to exhibit high levels of optimization (i.e., high positive affect) and low complexity (e.g., high denial and repression), whereas younger individuals showed high levels of affect complexity (Labouvie-Vief & Medler, 2002). Consistent with these cross-sectional results, a 6-year longitudinal study (Labouvie-Vief, Diehl, Jain, & Zhang, 2007) documented a developmental trend in increasing optimization and decreasing complexity in older adults. Taken together, these findings illustrate that age-related losses in cognitive control are associated with a compensatory response toward affect optimization.

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Additionally, dynamic integration theory suggests that cognitive declines throughout the aging process result in decreases in emotion regulation capacity (Labouvie-Vief, 2003). In particular, deterioration of executive functioning may contribute to deficits in older adults' inhibitory control in emotionally charged or highly arousing circumstances. For example, a cross-sectional study by Wurm and colleagues (2004) revealed that older adults (52–92 years) had difficulty inhibiting irrelevant information as well as processing high-arousing words during emotional Stroop tasks as compared to younger adults.

Overall, the current body of research consistently documents an age-associated shift in emotional experience. Although socioemotional selectivity theory and dynamic integration theory propose divergent explanations for this developmental pattern, the empirical evidence consistently supports the association between advanced age and positive emotion, especially among high-functioning older adults.

### Aging and Emotion Regulation

Integrative theories posit that increases in emotional well-being across the lifespan may be explained by older adults' enhanced ability to modulate emotional experiences. These models suggest that emotion regulation processes vary with age and further predict when and why these abilities change across the lifespan. Alongside theoretical predictions, empirical evidence supports an association between emotion regulation and positive psychological outcomes (Gross & John, 2003).

### Optimizing Emotional Experience in Later Life

Extending from Baltes and Baltes' (1990) meta-theory of successful aging, Urry and Gross (SOC-ER; Urry & Gross, 2010) recently put forth a framework of selection, optimization, and compensation with (p. 118) emotion regulation. Consistent with socioemotional selectivity theory, this model highlights motivation as a key factor in prompting the use of specific regulation strategies in the service of well-being. SOC-ER proposes that older adults compensate for changes in internal (i.e., cognition) and external (i.e., social engagement) resources through capitalizing on emotion regulatory strategies. In particular, the framework suggests five points at which emotion may be modulated in the emotion generative process: (1) selection of the situation, (2) modification of the situation, (3) deployment of attention, (4) change of cognitions, and (5) modulation of behavioral responses. Divided into antecedent- and response-focused regulatory strategies, the first four (antecedent-focused processes) are employed before emotion response tendencies are fully activated, whereas modulation of behavior (a response-focused process) appears only once an emotion is already under way (Gross & John, 2003).

Older adults tend to engage in antecedent-focused emotion regulation strategies more frequently and with greater efficiency than do younger adults, who tend to employ more response-focused strategies (John & Gross, 2004). Age differences in both types of processes (antecedent- and response-focused) have been most widely documented in

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studies of attention deployment, reappraisal, and suppression. Older adults use attentional deployment when confronted with negative stimuli, whereas younger adults display a looking preference in congruence with their mood (Isaacowitz et al., 2008). These gaze patterns are clearly represented in the SOC-ER framework as antecedent-versus response-focused processes and are hypothesized to contribute to age-related differences in escaping bad moods and retaining positive experiences (Isaacowitz et al., 2009).

Through mood induction procedures, studies have shown that the ability to implement *positive reappraisal* increases with age, whereas the ability to implement *detached reappraisal* (i.e., deliberate redirection of attention away from emotionally charged stimuli) declines (Shiota & Levenson, 2009). These findings reveal an age-related shift in emotion regulation and provide a framework for subsequent research aimed at exploring the influence of individual and contextual variation in emotion regulation processes across age cohorts.

### Preserving Emotional Well-Being Through the Strengths of Aging

As an alternative account of emotion regulation, the model of strength and vulnerability integration (SAVI), by Charles (2010), proposes that older adults draw on specific strengths of aging (e.g., situational appraisals, selective attentional strategies, goal-oriented behaviors) to promote positive emotional well-being. In accordance with socioemotional selectivity theory, SAVI maintains that both motivation and temporal horizons each contribute to the age differences in emotion regulation. Extending the socioemotional selectivity theory framework, the SAVI model contends that, with accumulated life experience, older adults learn how to cope with and avoid negative situations.

As hypothesized by SAVI, age differences in emotion regulation have emerged in studies of situational appraisals and behavior. These findings are particularly provocative within the context of interpersonal relationships. For instance, older adults report being in a more positive and less negative mood when they interact with family members; they also tend to avoid arguments more than do younger adults (Charles & Piazza, 2007; Charles, Piazza, Luong, & Almeida, 2009). As a means of preserving interpersonal harmony and maintaining positive emotional well-being, older individuals employ passive, rather than active tactics, such as avoiding confrontation or avoiding negatively charged situations altogether (Blanchard-Fields, Chen, & Norris, 1997). Notably, these strategies are proposed to assist older adults in optimizing positive emotional experiences.

Although studies examining appraisals, memory, and behavior provide a consistent picture of age differences in emotion regulation, evidence of age differences in response to stressful situations is relatively sparse (Charles, 2010). SAVI proposes that, when confronted with unrelenting or persistent stressors, older adults may be unable to employ emotion regulation strategies. Specifically, in the face of uncontrollable stress, neurological dysfunction, and loss of social belonging (Charles, 2010), it may not be

possible for older adults to disengage from or de-escalate negative experiences. Thus, a minority of individuals may experience affective distress due to prolonged physiological arousal.

### Future Directions in Emotion Regulation

Overall, older adults benefit from enhanced emotion regulation; however, individual and contextual variation may account for observed differences in emotional experience. Personality, for example, may differentiate individuals in their abilities to draw on positive emotions in coping processes (Charles, [\(p. 119\)](#) 2010). More specifically, those high in the trait of neuroticism may be less adept at modulating emotional experiences (Mroczek & Almeida, 2004). It has since been hypothesized that this failure to regulate emotional experience may be a result of heightened reactivity to daily stressors (Mroczek et al., 2006), as well as to increased sensitivity to physiological arousal (Eysnck, 1963). Over time, the accumulation of these responses may leave older adults high in neuroticism less able to employ emotion regulation strategies (Charles, 2010). Thus, examining individual differences and emotion regulation in a prospective and longitudinal fashion may help illuminate changes across the lifespan. Moreover, although most people report decreasing levels of negative affect over time, individuals high in neuroticism report stable and high levels of negative affect (Charles et al., 2001) in addition to poorer emotion regulatory abilities (Mroczek & Almeida, 2004). Expanding on this work would help tease apart how positive emotion regulation strategies change across the lifespan, as well as how personality components may either facilitate or hinder these regulatory processes.

Although individual variation may account for some of the differences in well-being, research has yet to uncover whether specific regulatory strategies may serve to enhance positive emotional experience across the lifespan. However, some scholars propose that *savoring* (i.e., a deliberate and conscious awareness of pleasant emotional experiences) may be one regulatory strategy that promotes overall health and well-being for both the young and old (Bryant, 2003; Wood, Heimpel, & Michela, 2003). Whereas people who employ this mode of control experience advantages in well-being, those who engage in the converse—the *dampening* of positive emotions—may have less favorable outcomes (Tugade & Fredrickson, 2007). Notably, *savoring* has been linked with self-esteem and self-control, as well as optimism and life satisfaction (Bryant, 2003). Although correlational in nature, such findings suggest that savoring may confer an array of benefits.

In light of evidence that emotion regulation promotes affective well-being (Charles, 2010; Urry & Gross, 2010) and that positive emotions facilitate better coping and self-regulation strategies (Aspinwall, 1998), it becomes important to understand whether there is a reciprocal influence of emotional well-being and positive regulatory strategies and whether this effect varies by age. For instance, because older adults tend to experience more positive emotions as compared to younger adults (Mroczek, 2001), are they more readily able to draw on their positive emotional experiences as a means of enhancing

their regulatory abilities? Recent models of attention suggest that this may be the case (Wadlinger & Isaacowitz, 2011 but have yet to explore how this may manifest differently in older and younger adults.

In sum, research points to an age-associated shift in affective well-being despite pervasive declines in cognitive processes. Although theories of emotional aging pose differing accounts of the underlying mechanisms, that positive emotions remain largely stable over the life course may have strong implications for physiological processes, especially as they contribute to overall physical health.

## Pathways Linking Positive Emotions to Health

In this section, we present empirical evidence exploring four potential pathways by which positive emotions influence adult health: health behaviors, physiological systems, stressor exposure, and stress undoing (Ong, 2010). Recent reviews (Cohen & Pressman, 2006) indicate that the strongest associations between positive emotions and health are from prospective studies examining stable emotional *traits*. In addition, investigations exploring the role of naturally occurring or induced emotional *states* highlight the importance of positive emotions in delaying the onset of age-related biological decline. Taken together, the current literature provides convincing evidence of the adaptive significance of positive emotion in later life, as well as foundational support for the underlying pathways that contribute to enhanced physical health.

### Health Behaviors

Growing research has identified health practices as playing a critical role in relation to risk for illness and disease (Adler & Matthews, 1994). Whereas negative habits (e.g., poor diet, physical inactivity) have health-damaging consequences, positive health practices (e.g., exercising, avoiding prolonged sun exposure) protect against the onset and development of acute and chronic conditions. Moreover, the consequences of such behaviors may have far-reaching effects, particularly as they accumulate with age; thus, maintaining positive health practices over time may be particularly crucial for older individuals.

Recent reviews document the prospective association between trait positive emotion and health-enhancing practices (Pressman & Cohen, (p. 120) 2005; Steptoe, Dockray, & Wardle, 2009), suggesting that positive emotions may foster engagement in positive health behaviors. One such example may be the restorative link between positive emotions and sleep. For instance, data from a study of 736 health adults (58–72 years) revealed an inverse association between trait positive emotion and sleep disturbance, even after controlling for age, sex, employment status, self-rated health, and psychological distress (Steptoe, O'Donnell, Marmot, & Wardle, 2008). Similar

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associations have been found in studies of narcolepsy patients and healthy controls in which positive emotions are linked with increases in sleep duration and decreases in fragmented rapid eye movement (REM) sleep (Fosse, Stickgold, & Hobson, 2002). These benefits may be particularly important for older individuals, given that poor sleep efficiency and greater sleep disturbance increase with advanced age (Bloom et al., 2009). Whereas cumulative sleep loss has negative health consequences that contribute to increased risks for adult morbidity and mortality, improved sleep quality confers a number of recuperative benefits to restore and revitalize the body (Kripke, Garfinkel, Wingard, Klauber, & Marler, 2002; Reid et al., 2006). Thus, positive emotions may indirectly promote overall health through enhancing sleep quality and rest.

Positive emotions not only promote physical recovery and rejuvenation, but also enhance psychological well-being to restore bodily function. For instance, a study of surgical patients found that individuals who had views of the natural environment (e.g., trees and animals) not only recovered more quickly but also had shorter hospital stays and fewer postoperative complications than did patients whose views lacked natural settings (Ulrich, 1984). Importantly, positive emotion was a central factor hypothesized to facilitate recovery by promoting psychological well-being. Although these studies highlight the association between trait positive emotion and salutary health outcomes (through promoting adaptive health behaviors), recent inquiries indicate that the favorable effects of psychological well-being on mortality are present after taking health behaviors into account (see Chida & Steptoe, 2008, for a review). Such evidence further indicates that there may be alternative pathways through which positive emotions influence adult health.

### Physiological Systems

In addition to exploring behavioral mechanisms, research examining biological pathways has begun to illuminate the relationship between positive emotion and physiological outcomes (Ong, 2010; Steptoe, O'Donnell, Badrick, Kumari, & Marmot, 2008). Allostatic load or the “wear and tear” that results from chronic or repeated elevation of the body's stress response systems implicates deleterious physiologic changes in the body (McEwen, 1998). Over the life course, the accumulation of these alterations may confer health-damaging consequences, ultimately resulting in chronic pain and illness (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002). Although persistent physiological arousal can have detrimental effects on physical health, accruing evidence indicates that positive emotion may have direct and indirect effects on these systems and may play a role in mitigating the age-related health declines that result from physiological stress and strain (Pressman & Cohen, 2005).

Studies of diurnal cortisol, a biological marker of stress, illustrate the importance of trait positive emotion in relation to physiology. In a large-scale study of 2,873 healthy men and women (aged 57–74), Steptoe and colleagues (2007) assessed associations between inflammatory markers, cortisol levels, and positive affect. Results indicated that, for

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women in particular, positive affect was associated with lower levels of cortisol, even after adjusting for sociodemographic (e.g., age, gender, income, and ethnicity) and physical (e.g., body mass index, waist/hip ratio) characteristics. Other research has examined the relationship between cortisol and positive emotions within the context of life events. A recent study employing data from the Midlife in the United States (MIDUS) survey and the National Study of Daily Experiences (NSDE) (Ong, Fuller-Rowell, Bonanno, & Almeida, 2011) found that spousal bereavement was associated with cortisol dysregulation. Importantly, mediational analyses showed that lower levels of positive emotion following the loss accounted for the observed differences in the cortisol slopes. This finding further suggests that positive emotions may play an important role in neuroendocrine functioning. Extending existing research, a study of middle-aged men and women (45–59 years) (Steptoe, Wardle, & Marmot, 2005) examined the protective effects of positive emotions on neuroendocrine, cardiovascular, and inflammatory processes. Results revealed inverse associations between happiness and salivary cortisol, heart rate, and fibrinogen (a marker of immune competence) stress responses. Notably, the effects demonstrated by the aforementioned studies were independent of trait negative emotion, indicating that the pathway (p. 121) by which positive emotions promote salubrious health outcomes is distinct from that of psychological distress.

Additional evidence suggests that age-related alterations in immunocompetence may also accelerate declines in physical health. In particular, advanced age has been linked with dysregulation of normal cellular processes and decreases in natural killer cell cytotoxicity (NKCC) functionality, as well as increases in inflammatory markers, such as interleukin-6 (IL-6) and C-reactive protein (CRP). Research on older adults demonstrates the importance of positive mood on age-related decreases in immune response. Employing a sample of eighteen healthy individuals (75–91 years) who had recently received the influenza vaccine, Costanzo and colleagues (2004) found that those who reported higher levels of optimism and vigor had greater cytokine responses.

Positive emotion may also work to suppress stress-induced elevations of inflammatory markers and increase levels of certain antibodies. In a study of healthy men and women (35–55 years), Steptoe, O'Donnell, Badrick, Kumari, and Marmot (2008) found trait positive emotion was associated with reduced levels of both IL-6 and CRP in women (but not in men). This finding concurs with those from a review of eight studies that revealed associations between induced positive mood and increased levels of immunoglobulin A (sIgA), an important antibody known to protect against viral and bacterial infection (Marsland, Pressman, & Cohen, 2007).

Viral-challenge studies also substantiate the protective effect of positive emotions, particularly in relation to cold incidence and infection. For example, in a study by Cohen and colleagues (2006), healthy individuals (18–54 years) with positive emotional style (PES) exhibited lower risk of developing illness symptoms after exposure to a respiratory virus. Notably, this prospective link emerged even after controlling for sociodemographic characteristics, virus-type, and dispositional variables, including negative emotional style (NES). Similar findings were reported in a study of 327 young and middle-aged adults

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(18–54 years) (Doyle, Gentile, & Cohen 2006). Results revealed that, independent of NES, PES was associated not only with decreased illness expression of two rhinoviruses, but also with lower levels of IL-6.

Further, positive emotion may benefit the health of older adults by protecting against bodily deterioration and attenuating pain symptoms. A study of 124 women (35–72 years) with osteoarthritis and fibromyalgia, Zautra, Johnson, and Davis (2005) showed a prospective association between higher levels of positive affect and lower levels of pain symptoms. In addition, a large-scale study of noninstitutionalized Mexican Americans (65–95 years) revealed an association between trait positive affect and a 3 percent decrease in risk of frailty. The results still held after controlling for background variables, including demographic characteristics and preexisting medical conditions (Ostir, Ottenbacher, & Markides, 2004). In general, the data suggest that positive emotion may protect against deterioration of physiological systems and contribute to salutary health outcomes as a result.

### Stressor Exposure

Prolonged activation of stress-response systems confers risk for poor health outcomes. Moreover, differential exposure to stressors may contribute to heightened physiological reactions and further precipitate age-related declines in adult health and well-being (Kiecolt-Glaser & Glaser, 2001). Whereas the accumulation of stressors and negative life events accelerates physical decline, positive emotions may play a role in mitigating exposure to stressors associated with aging.

Earlier work suggests that stress may interact with age to accelerate deterioration of immune responses (Cohen & Williamson, 1991), ultimately leading to compromised health in the form of infectious disease, inflammation, and illness. Moreover, exposure to stressful events may contribute to immunosenescence among older adults, although positive emotion may dampen such effects. A prospective study of fifty-eight older adults (65–89 years) explored the relationships between participants' mood and cellular immune response before and after housing relocation (Lutgendorf et al., 2001). Overall, movers presented lower NKCC than did controls, but independent of the effects of group (mover vs. nonmover), higher levels of vigor and optimism were linked to greater NKCC at baseline and follow-up.

Positive emotion may help to reduce stressor exposure within the context of both chronic and acute conditions. More specifically, positive emotion has been linked to reduced risk for morbidity, including coronary problems. For example, in a 6-year prospective cohort study of older adults (65 years and older), Ostir and colleagues (2001) found an inverse relationship between positive affect and stroke incidence, after adjusting for sociodemographic and health characteristics. In addition, happiness has been shown to predict lower hospital readmission rates among patients with chronic (p. 122) disease (55 years and older), suggesting that positive emotions are protective against exposure to

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stressors after illness (Middleton & Byrd, 1996). Studies such as these reveal the importance of positive emotions in allaying exposure to health conditions and illness (Chida & Steptoe, 2008; Pressman & Cohen, 2005).

Collectively, these studies provide support for the association between positive emotions and reduced stressor exposure. Although increased exposure to stress may accelerate declines in physical health and exacerbate normative age-related changes in physiology, positive emotions may mitigate these effects. In sum, the findings reviewed here reveal a protective link between positive emotion and stressor exposure; however, full exploration of the underlying pathways has yet to be established by empirical research.

### Stress Undoing

Positive emotions influence health not only via behavioral and physiological pathways, but also through *undoing* the adverse effects of stress. Age differences in stress reactivity and recovery have been documented in studies of cardiovascular (Uchino, Birmingham, & Berg, 2010) and immune function (Piazza, Almeida, Dmitrieva, & Klein, 2010). These studies reveal that older adults show greater physiological responses to stress-induced stimuli than do younger individuals.

Ambulatory assessments, for example, provide evidence in support of the stress undoing hypothesis, demonstrating that positive emotions may be instrumental in attenuating the effects of daily stress (e.g., Ong, Bergeman, & Bisconti, 2004; Ong, Bergeman, Bisconti, & Wallace, 2006). In particular, diary studies have explored the role of psychological well-being in reducing stress-induced elevations in blood pressure and heart rate variability. For example, one 60-day diary study of emotions and cardiovascular activity revealed an association between daily positive well-being and reduced cardiovascular reactivity to negative emotional arousal in older adults (60–87 years) (Ong & Allaire, 2005). Concurring with and adding to these findings, research examining positive mood has documented links between positive affect and lower blood pressure reactivity and suppressed cortisol levels (Brummett, Boyle, Kuhn, Siegler, & Williams, 2009). In addition, positive emotions may also facilitate stress undoing by alleviating pain symptoms and severity. For instance, in middle-aged women (42–76 years) with rheumatoid arthritis or osteoarthritis, weekly positive emotions mitigated the association between negative emotion and reports of pain (Zautra, Smith, Affleck, & Tennen, 2001). Such protocols illustrate the multiple pathways by which positive emotions may attenuate reactivity and facilitate stress recovery on a daily basis.

Not only do positive emotions attenuate stress reactivity, but they also assist with recovery from physiological arousal and pain. Such associations are most often captured in laboratory protocols. In younger adults, for example, induced positive emotion has been shown to hasten the return of heart rate and blood pressure to baseline levels (Fredrickson, Mancuso, Branigan, & Tugade, 2000), as well as to assuage induced pain. For example, when presented with a cold-pressure pain hand-immersion task, college-

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aged volunteers who were asked to imagine pleasant scenes showed increases in pain tolerance after treatment (Hertel & Hekmat, 1994). The link between positive emotions and reduced stress is also present within clinical samples. In an illustrative study, Rotton and Shats (1996) examined the salutary effects of induced humor in seventy-eight patients (18–65 years) admitted to the hospital for orthopedic surgery. Participants who watched humorous films not only requested smaller doses of minor medication postsurgery, but also self-administered lower doses of major analgesics.

Taken together, the previously reviewed studies illustrate plausible pathways that underlie the association between positive emotion and adult health outcomes. Through enhancing health behaviors, reducing activation of physiological processes, diminishing stressor exposure, and attenuating stress reactivity and recovery, positive emotions appear to confer an array of health benefits, especially in later life. Although the current literature provides provocative evidence for the protective effect of positive emotions on physical well-being, additional research is needed to examine this relationship in greater detail.

## Emotional Experience and Health

Although the focus of this essay is on the link between positive emotions and health, alternative interpretations of this relationship certainly warrant acknowledgment. For instance, it is plausible that the experience of positive emotions may stem from a more general disposition or set of traits. Scheier, Carver, and others point to trait optimism as conferring beneficial physical and psychological outcomes. Such literature has identified pathways (p. 123) by which optimism may promote effective coping during stress and thus enhance overall health and well-being (Scheier & Carver, 1992). Positive thinking may also underlie self-regulation, allowing individuals to engage in health-enhancing behaviors to recover faster from acute conditions (Scheier et al., 2003) as well as to adapt to enduring and chronic illnesses (Scheier & Carver, 2001). Alternatively, personality theorists note that certain characteristics are linked with engagement in regulatory processes known to enhance health and behaviors (Booth-Kewley & Vickers, 2006). As such, positive emotions may be one piece of a more complex puzzle. The dynamic interplay among regulatory processes, emotional experience, and stress reactivity may assist individuals in overcoming illness and ultimately contribute to protective benefits for health, longevity, and quality of life.

## Future Directions for Theory and Research

The data presented here, along with lifespan theories of emotion, substantiate the link between positive emotions and health; however, some gaps and inconsistencies in the literature remain. In the following section, we delineate directions for future research

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that illustrate the utility of applying theoretical frameworks in uncovering the role of positive emotions in maintaining health.

### **The Positivity Ratio and Well-Being**

The link between positive emotions and health is well documented. Few studies, however, specify a particular threshold necessary for optimal human functioning (Keyes, 2002). Researchers have begun to explore this issue and propose that a ratio of positive to negative emotion at or above 2.9 to 1 may be necessary for optimal mental health in younger adults (Fredrickson & Losada, 2005). Building on these earlier findings, recent studies indicate the importance of maintaining a high positive to negative emotion ratio across variety of domains. Importantly, the balance of positive to negative emotions has been shown to increase longevity and delay mortality. In particular, empirical work suggests that positivity is predictive of survival (Carstensen et al., 2011) and lower mortality risk (Ong, Mroczek, & Riffin, 2011).

Although such evidence supports the link between positivity and flourishing, some research calls into question whether this association is, in fact, due to a “healthy aging effect.” In the face advanced disease, such as breast cancer (Brown, Butow, Culjak, Coates, & Dunn, 2000) and renal disease (Devins et al., 1990), high levels of positive emotion may be detrimental to well-being. To explore this relationship further, future studies may benefit from examining the extent to which positive emotions predict survival in the context of both preventable and unpreventable causes of death. Research in this area would thus disentangle whether this association is stronger for preventable causes rather than for those that are unavoidable.

Recently, research has begun to provide a more nuanced picture of the health benefits of the positivity ratio. In particular, results from a daily diary study (Diehl, Hay, & Berg, 2011) revealed that, although the ratio predicted mental health in young adults, it did not reliably distinguish mental health status among middle-aged and older individuals. Findings such as these highlight the importance of examining this ratio not only across the lifespan, but also within a variety of contexts. Because this “critical level” of positivity may vary by age, researchers suggest that it may be important to identify age-graded positivity ratios across health domains in future studies (Diehl et al., 2011).

### **Positive Emotions and Physiology Across the Lifespan**

Although laboratory and naturalistic studies document the salubrious effects of positive emotion across age cohorts, few explicitly compare both younger and older adults within the same investigation. Given existing empirical evidence, plausible hypotheses can be made in exploring potential age differences in the physiological manifestation of emotion.

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Formal tests of these predictions may further contribute to uncovering the potential pathways linking positive emotion and health.

Meta-analytic reviews suggest that physiological arousal is associated with varying levels of emotion activation (Pinquart, 2001; Pressman & Cohen, 2005). Whereas acute or high-activated emotions (e.g., enthusiasm, excitement) trigger greater physiological responses, unactivated positive emotions (e.g., calm, relaxed) tend to elicit smaller reactions. Notably, low- and high-activated emotions may have differential effects on adult health. Activated positive emotions, for instance, are associated with heightened cardiovascular and immune responses. Unactivated positive emotions, on the other hand, may benefit neuroendocrine function (Pressman & Cohen, 2005), as well as specific cognitive processes and social behavior (Isen, 2008).

Importantly, emotion activation may vary by age (Pinquart, 2001; Pressman & Cohen, 2005). (p. 124) Findings from a recent study (Kessler & Staudinger, 2009) suggest that although comparable levels of high-arousal positive emotion exist across age cohorts, levels of low-arousal positive emotion increase over time. Cross-sectional investigation of age differences in activation-arousal may reveal important variations in health outcomes associated with physiological changes and, furthermore, may reveal how mild positive emotions may promote resilience across the lifespan. In addition, longitudinal work is necessary to uncover the extent to which these differences change over time. More specifically, longitudinal comparisons of cross-sectional age differences would distinguish cohort effects from developmental patterns of change, providing an integrated portrayal of age-related alterations in emotion and health.

Although study in this area appears promising, prior research on the health effects of activated and unactivated positive emotions has been hampered by methodological limitations. Experimental studies have failed to include manipulation checks of specific mood inductions. Correlational studies often neglect to control for negative emotion. In spite of these methodological shortcomings, future investigation of age-related differences in physiological manifestations of emotion would highlight a potential underlying mechanism by which emotional experience is connected to adult health (Pressman & Cohen, 2005).

## Conclusion

Although growing evidence reveals age differences in emotion and emotion regulation processes, questions concerning the underlying mechanisms remain largely unanswered. Inquiries into the physiological manifestations of positive emotions are just beginning to probe this area of research, but additional work is necessary. Future exploration of age-associated changes in emotions and accompanying regulatory processes will not only

reveal a nuanced picture of this phenomenon, but also aid in uncovering the importance of positive emotions in later life.

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