Embodying Psychological Thriving: 
Physical Thriving in Response to Stress

Elissa S. Epel*
Yale University

Bruce S. McEwen
Rockefeller University

Jeannette R. Ickovics
Yale University

In addition to the context of psychological health, thriving can be measured in the context of physical health. Moreover, thriving may be operationalized at a macro level (e.g., improved functional health status following acute illness or injury) or at a micro level (e.g., hormonal balance). The goal of this article is to examine physical thriving at the micro level, by investigating hormonal responses to stressful situations. In addition, we examine the role that psychological factors play in this relationship. Although stress-induced arousal has traditionally been viewed as negative, certain endocrine responses to stress can be health enhancing. Specifically, we propose that physical thriving results when there is a greater amount of growth promoting or anabolic hormones (e.g., growth hormone) than catabolic hormones (e.g., cortisol). Characteristics of the stressor (duration, frequency, and controllability) as well as psychological moderators such as one’s cognitive appraisal of the stressor (threat versus challenge) play a role in determining the profile of response to stress. When an individual appraises intermittent stressors as controllable, she or he may display a resilient profile of stress hormone

*Correspondence concerning this article should be directed to Elissa Epel, VA Palo Alto Health Care System 116B, 3801 Miranda Avenue, Palo Alto, CA 94304; e-mail: elissa.epel@yale.edu

© 1998 The Society for the Psychological Study of Social Issues
responding—rapid cortisol responses with quick recovery, and more importantly, cortisol adaptation when faced with similar stressors over time. This stress response is in turn related to better health. To substantiate some of these issues, we present data from a study examining women's cortisol reactivity in response to a repeated laboratory stressor and their self-reported growth from facing trauma. The results suggest that women who have grown psychologically from trauma may show quicker cortisol habituation to other stressors. Cortisol adaptation to stress may serve as one potential marker of resilient psychological and physical functioning.

A discussion of psychological thriving in response to stress would not be complete without a description of the physiological correlates of such experiences. Throughout time, societies have believed in the interdependence of mind and body, and research is beginning to demonstrate their interactions empirically. Most health psychology research explores how negative emotions, cognitive variables, and stressors influence disease. However, there has been limited focus on how psychological responses to adversity can lead to enhanced health or physical thriving.

Psychological thriving in response to a stressor is defined as the acquisition of greater self-confidence and skills or the effective mobilization of resources moving beyond homeostasis (O'Leary & Ickovics, 1995). Physical thriving can be similarly defined as changes that lead to enhanced health. As Carver (this issue) describes, psychological thriving occurs when it is least expected. Similarly, under conditions of stress, one would expect a physically weakened system, but positive physiological changes can occur—often in the context of psychological thriving. In physiological terms, this translates into greater restorative (i.e., anabolic) processes than destructive (i.e., catabolic) processes at work.

This article describes how psychological thriving can lead to physical thriving and reviews a neglected body of research suggesting that it is possible to improve physical health through the process of coping effectively with stressors. In fact, there are unique pathways of developing physical resilience that actually require exposure to stressors, which can be called a toughening-up process. Toughening is a term first applied to rats who became more hardy after being exposed to stressors (Miller, 1980). An analogy to this toughening-up process is building muscle, where one needs to break down muscle initially to build a stronger muscle than before. As we describe in detail below, toughening up after a stressor may involve initial short-term catabolic processes, followed by greater anabolic processes, which can improve physical health.

We draw from psychoneuroendocrine research to show that in response to stressors, certain styles of cognitive appraisal and perceptions of control can transform the effects of stress arousal from potentially damaging to health enhancing. Thus, the chain of events from perception of stress to physiological response can
shape one's current state of health. Finally, we present new data from a study of cortisol responses to a chronic laboratory stressor that begins to validate resilient profiles of stress reactivity as a micro-level index of enhanced health.

**Defining Physical Thriving: Physical Thriving Is Not Merely the Opposite of Physical Decline**

The study of psychological thriving, as described in this issue, shows that thriving may be specific to only some dimensions of psychological well-being. For example, one could feel great distress in response to the diagnosis of terminal illness or the death of a spouse, but at the same time be adjusting well and even growing psychologically (see Massey, Cameron, Ouellette, & Fine, this issue; O'Leary & Ickovics, 1995; Zisook & Shuchter, 1991). Therefore, psychological health can be independent of psychological distress. Physical health is often measured by the mere absence of disease. However, like psychological health, physical thriving can be independent of disease, and in certain cases can even coexist with signs of disease. For example, a person with multiple sclerosis or an amputated limb may become a marathon runner (Hansen, Bayer, & Ickovics, 1998) and thus have excellent health on some dimensions, such as physical fitness, while still having a chronic disease or disability. Physical thriving is defined here as any physiological changes brought about as a result of facing stressors that leave one with greater physiological resilience than she or he had before facing adversity. We can also identify thriving as when the stressor is a disease or other health threat, and one remains more healthy than expected, given the physiological challenge. So physical thriving can refer both to enhanced health and to one's health status above the expected baseline in response to a stressor.

Stress can serve as a catalyst for physical changes, advancing one's physical state toward either health or disease. After facing stress, a healthy responding system may become more resilient, whereas a weakened system may be unable to grow following the stressor. It is important to identify measures of enhanced health and restorative activity (growth and repair) to better assess dynamic indices of health and identify psychological factors related to enhanced health.

Positive physical changes could be the result of behavior, such as increased exercise or other self-care behaviors, or changes in physiology mediated by stress-responsive hormones, which are the focus of this article. The most direct way psychological factors affect health is through the neuroendocrine response systems, which affect the functioning of nearly every physiological system at all stages of life. We review selective research on the psychoneuroendocrinology of stress, which offers some clues on how to identify and predict healthy physiological responses to stressors.
How Stress Leads to Thriving: Allostasis and the Balance Between Catabolic and Anabolic Processes

Enhanced health can result when the body has the physiological resources (and psychological resources, as we later argue) to build, maintain, and repair itself. This type of restorative activity is governed by many factors, such as nutrition, but also by hormones, especially the balance of hormones relative to each other. According to opponent process theory (Solomon, 1980), a strong negative state is followed by the opposing state, a positive state. Applying this to physical stress, once the body has mounted a protective response and adapted to stress (generally a catabolic process), the opponent process, which is restorative or anabolic, eventually takes over. Physical thriving depends partly on when and for how long the opponent process takes over.

As shown in Figure 1, the balance between anabolic and catabolic hormones affects whether the body is primarily in a destructive or restorative mode. The sympathetic nervous system drives arousal and the fight-or-flight response. During stress, the sympathetic nervous system releases hormones (such as glucagon, epinephrine, norepinephrine, and cortisol) to increase catabolic processes that inhibit digestion and break down metabolic compounds to quickly mobilize energy. Of the stress hormones, cortisol remains elevated for the longest period after stress, which has important long-term effects on our health (McEwen, 1998; Munck, Guyre, & Holbrook, 1984).

The parasympathetic nervous system triggers release of more anabolic hormones (e.g., growth hormone, insulin-like growth factor (IGF-1), insulin, and sex steroids) to counter arousal and increase relaxation, digestion and energy storage, and healing processes, such as promoting protein synthesis. For example, growth hormone supplementation, especially when administered with IGF-1, speeds wound healing and recovery from burns and injury (Bentham, Rodriguez-Arnao, & Ross, 1993; Mayer, Muller, & Herndon, 1996; Meyer, Barrow, & Herndon, 1996), whereas high cortisol increases protein breakdown, inhibits the growth of fibroblasts, and thus slows healing (Saito, Tazawa, Yokoyama, & Saito, 1997; Wajchenberg et al., 1995). Growth hormone is crucial to health, and growth hormone deficiency may be related to premature mortality (Korbonits & Besser, 1996).

The catabolic hormones, especially cortisol, are often antagonistic toward the more anabolic hormones (Sterling & Eyer, 1988; Unterman & Phillips, 1985), and vice versa (Horber & Haymond, 1990). Therefore, the body is constantly fine-tuning the balance between anabolic and catabolic functions, depending on the need. The ensuing level of arousal may play a large role in determining long-term health, and thus profiles of hormonal balance may serve as a window into one’s current state of health.

Allostasis describes the body’s ability to adapt to constantly changing environments (Sterling & Eyer, 1988) and thus can help describe physical thriving. An
Glucocorticoids (e.g., cortisol) 
Catecholamines 
Glucagon 

Catabolic Hormones

Growth hormone 
Insulin-Like Growth Factor (IGF-1) 
Insulin 

Anabolic Hormones

Actions

Break down body's resources

- increase arousal
- break down protein
to free up resources (proteolysis)
- store fat instead of lean mass

Maintain and repair body

- increase relaxation
- cell repair (protein synthesis)
- store lean mass

Chronic stress → exhaustion of resources

Enhanced health → efficient utilization
of energy

Fig. 1. Destructive versus restorative hormones and processes.

ideal or tight allostatic system is one that moves from high to low levels of arousal flexibly and fluidly, depending on the demands. Catabolic hormones are essential to health over the short term. However, when the body is under chronic stress and in a constant state of arousal, these hormones themselves can cause damage, which has been called allostatic load or physical damage due to stress (McEwen & Stellar, 1993). This damage leaves the body less able to respond flexibly to changes in the environment.
Overexposure to stress weakens the counterregulatory systems, which leaves the body in a greater catabolic state. In addition to stress, aging can shift resting levels of hormones from a restorative to a more catabolic state. In fact, *failure to thrive syndrome*, including weight loss and muscle atrophy among the elderly, is thought to be in part due to a greater level of catabolic than anabolic hormones (Verdery, 1995).

The ratio of anabolic to catabolic hormonal levels may be the most sensitive indicator of one's state of anabolic functioning and potential for growth, which we refer to as the *growth index*. Thus, we conceptualize the growth index as a predictor of allostatic load, and allostatic load as preclinical disease processes and thus a predictor of more serious disease outcomes.

A typical profile of neuroendocrine health (a high growth index) is reflected by higher resting levels of growth-promoting hormones and sex hormones (Esler et al., 1981) accompanied by lower levels of stress hormones (cortisol and catecholamines). As shown in Figure 2, we propose that neuroendocrine health status can be measured by assessing the ratio of one's anabolic to catabolic hormones at rest. A predominance of anabolic hormones or a positive growth index (Panel A) reflects enhanced health or physical thriving and low allostatic load. This is a state of positive health in which the body is prepared to respond efficiently to stressors and in the meantime is building its defenses. When there are equivalent levels of both anabolic and catabolic processes or no growth (Panel B), there are few changes in health status but also little resilience to the wear and tear of aging. Lastly, a predominance of resting catabolic activity (Panel C) indicates a lack of growth, high allostatic load and disease processes, and eventually poor health.

*When Does Physical Thriving Occur? Types and Timing of Arousal Conducive to Physical Thriving*

Stress reactivity has traditionally been viewed as negative and associated with suppressed immunity, hypertension, diabetes, and coronary disease (Chrousos & Gold, 1992; Dhabhar & McEwen, 1997; McEwen, 1998; Troxler, Sprague, Albanese, Fuchs, & Thompson, 1977). The inevitable exposures to stress and occurrence of aging underscore the importance of identifying when salutary processes occur. Animal research has identified stage 2 of Selye's General Adaptation Syndrome, when the animal is adapting to chronic stress, as a time when "rejuvenating homeostatic mechanisms" can be observed, related to learning (Riga & Riga, 1996). Applying this to thriving, through facing stressors and being exposed to large amounts of stress hormones, the body may be triggered to restore greater balance in the growth-promoting counterregulatory hormones. In humans, it is important to discover under what conditions healthy adaptation takes place. We have identified three conditions that may promote physical thriving: (1) exposure to acute stressors rather than unrelenting chronic stressors; (2) toughening through
Physical Thriving in Response to Stress

Fig. 2. Health as reflected by the ratio of anabolic to catabolic hormones. Panel A depicts the ratio in physical thriving (growth index = positive, greater anabolic to catabolic; low allostatic load); Panel B, that in static health (growth index = 0, equal balance of anabolic to catabolic; average allostatic load); and Panel C, that typical of poor health (growth index = negative, greater catabolic to anabolic; high allostatic load).

repeated exposure to acute stressors; and (3) relaxation, or periods of reduced arousal below baseline.

Acute stressors, chronic stressors, and growth. It is clear that chronicity of stress is one of the most important moderators of thriving simply because chronic stress blocks opportunities to thrive physically. As with psychological coping, physical responses must be flexible to cope with different types of stressors. However, chronic stress leads to altered response profiles that reflect allostatic load and the loss of flexibility to respond to stressors efficiently, which prevents growth. For example, when chronic stress leads to elevated cortisol, overexposure to cortisol
itself can damage many systems (McEwen, 1998; McEwen & Stellar, 1993; Munck et al., 1984) and impair the hypothalamic-pituitary-adrenal axis negative feedback loop's ability to suppress further cortisol secretion (Sapolsky, Kray, & McEwen, 1986). This in turn leads to a poor shutoff response and thus slower cortisol recovery. In addition to this failure to shut off the stress response, chronic stress can lead to other stereotyped aberrant response profiles, such as failure to mount an adequate stress response or being unable to adapt to familiar stressors (McEwen). These rigid responses lead to over- or underexposure to cortisol.

Chronic stress and elevated cortisol can in turn transform effects of anabolic hormones from protective to detrimental. For example, high cortisol leads to high insulin, and together, these lead to insulin resistance and greater central fat deposition, a risk factor for disease (Kissebah & Krakower, 1994). Acutely, high cortisol leads to high growth hormone, which leads to the growth-promoting IGF-1. Chronically, high cortisol can lead to high growth hormone but low IGF-1, and thus growth hormone resistance (Bentham et al., 1993; Unterman & Phillips, 1985), rendering growth hormone ineffective at countering the stress response. Needless to say, these altered hormonal levels lead to a predominantly catabolic state, preventing growth and thriving.

On the other hand, acute stress, partly via cortisol reactivity, can actually enhance immunity temporarily (Dhabhar & McEwen, 1996; Dhabhar, Miller, McEwen, & Spencer, 1996). The cortisol response to acute stressors also prevents other components of the stress response from becoming too toxic and damaging organs (Munck et al., 1984). A growing body of evidence from animal studies shows that arousal from stress can have other positive effects on physiology, mainly when the stress is intermittent rather than chronic (for reviews, see Aldwin & Stokols, 1988; Dienstbier, 1989). Acute intermittent stress necessitates the opposing anabolic systems to bounce back, allowing tight allostasis, whereas chronic stress wears catabolic systems out and results in allostatic load, which facilitates disease processes.

**Toughening and growth.** Stress arousal can lead to enhanced health by toughening up the stress response systems and thus conditioning the body to be resistant to future stressors. A series of classic animal studies by Weiss and colleagues (Weiss & Glazer, 1975; Weiss, Glazer, Pohorecky, Brick, & Miller, 1975) demonstrated that when animals were under chronic stress, they suffered from learned helplessness and reduced central norepinephrine. However, when exposed to intermittent stressors, they showed signs of physiological toughening (Miller, 1980; e.g., resistance to catecholamine depletion, high peripheral catecholamine responsivity, increased beta receptor sensitivity, and suppression of cortisol). Toughening was in turn related to better performance and stable emotionality (Dienstbier, 1989). Having time to recover from stress appears to be a crucial moderator in determining the effects of stress on both psychological well-being and physiological functioning.
Physical Thriving in Response to Stress

Toughening in rats is also related to the definitive health outcome: mortality. Daily exposure to mild stress increased rats’ average life span by 18% (Frolkis, 1981). Thus, it appears that intermittent exposure to stressors that allows for time to recover before facing additional stressors may lead to resilience to future stressors. Similarly, when rat pups are exposed to handling or mild shock, their hormonal and behavioral responses to stress become much more resilient later in life, showing lower basal cortisol levels, quicker peak responses and recovery, stronger immunity, quicker physical development, fewer conflict-induced ulcers, less behavioral fear, and quicker avoidance learning (Gray, 1971; Levine, Haltmeyer, Karas, & Denenberg, 1967; Solomon & Amkraut, 1981). Finally, mild chronic stress administered before exposure to a carcinogen has been related to slower tumor growth (Monjan, 1981).

These studies have been used as an argument for exposing children to brief manageable stressors rather than oversheltering them. Clearly, some types of stressors, for limited durations, at specific developmental times, can be adaptive and transformative. This is in parallel to findings that stressors can enhance psychological resilience and competence (Garmezy, Masten, & Tellegen, 1984). Thus, exposure to manageable stressors can lead to physiological toughening—changes that decrease time spent in a catabolic state and boost immunity.

Adaptation to stressors as a form of toughening. Another example of toughening is increased speed of habituation to stressors. For example, we can examine changes in one’s stress hormones over time in response to repeated exposures to the same stimuli. Lack of adaptation to stress, when individuals consistently react to familiar stressors, can cause intermittent stress to develop into chronic stress arousal. Although initial reactivity in response to novelty, uncontrollability, or perceived stress may reflect healthy functioning, repeated reactivity or nonhabituation to the same stimuli may over time lead to cortisol overexposure. In rats, severe stress can lead to nonhabituation or even sensitization of cortisol responses (Ottenweller et al., 1992; Pitman, Ottenweller, & Natelson, 1990). In humans, whereas cortisol usually habituates after the first exposure to repeated stressors (Gunnar, Connors, & Isensee, 1989; Levine, 1978; Mason, Brady, & Tolliver, 1968), certain individuals, such as hypertensives and men with negative psychological traits, can take longer to adapt (Al Absi & Lovallo, 1993; Kirschbaum et al., 1995).

In sum, quick adaptation to a familiar stressor may reflect physical thriving, reducing the amount of wear and tear on the body and increasing amount of time in restorative mode. Facile adaptation likely reflects psychological processes such as increased learning and psychological hardiness.

We speculate that when there is a manageable challenge, the anabolic component of the stress response increases. Few studies to date have examined this. In one study, Farrace and colleagues hypothesized that teachers of flying would experience training flights as a manageable challenge, whereas the student novice pilots would experience the training flights as a potential threat. After exposure to a
training flight, the student pilots showed increased cortisol, growth hormone, and prolactin—a typical stress response—whereas the experienced teachers showed only an increase in growth hormone, but not of cortisol (Farrace, Biselli, Urbani, Ferlini, & De Angelis, 1996). As previously explained, high cortisol (with or without high growth hormone) is a high-cost catabolic stress response, whereas growth hormone alone, without the antagonistic effects of cortisol, should lead to growth and health (Panel A of Figure 2). Thus, for experienced pilots, we speculate that the manageable stressor of flying may be related to a positive profile of growth. Clearly, more research is needed to examine the clinical effects of a predominant cortisol versus growth hormone response to stress.

Relaxation and growth. In addition to the chronicity of stress, the preexisting level of allostatic load affects thriving. To mobilize a large anabolic counterregulatory response, one’s allostatic load must be low (Panel B or C of Figure 2). Therefore, a second crucial condition for physical thriving is having restorative breaks from stress—or opportunities for relaxation. Relaxation may lead to these “rejuvenating homeostatic mechanisms” in which restorative functioning prevails and thus may be especially important in preventing or decreasing allostatic load.

Relaxation techniques, such as meditation, have been shown to suppress basal cortisol levels (Alexander, Langer, Newman, Chandler, & Davies, 1989; Gallois, Forzy, & Dhont, 1984; Jevning, Wilson, & Davidson, 1978; Sudsuang, Chentazez, & Veluvan, 1991). In a prospective random assignment study, meditators showed decreases in basal cortisol over four months as well as increases in reactivity to stress (Maclean et al., 1997). This profile of response is strikingly similar to the healthy profile of response proposed by Dienstbier (1989) and that found in dominant baboons (Sapolsky, 1982).

To summarize findings on positive arousal, the opposing forces of arousal and relaxation are both necessary to adapt to our changing environment. Relaxation increases the growth index by decreasing catabolic and increasing anabolic processes. Positive arousal from facing manageable stressors may increase growth through short-term increases in catabolic processes, followed by strong counterregulation by anabolic processes. Only by examining the speed of recovery and response to repeated exposures can we determine toughened or resilient stress responding. Our data, presented later, support the idea that cortisol adaptation to repeated stress is related to psychological thriving. In humans, because we are constantly exposed to potential stressors, which response system prevails at what stage of facing stressors is partly under psychological control.

Psychological Responses to Stress and Growth

In addition to characteristics of the stressors, an individual’s psychological responses to stressors can moderate their effects. Cognitive appraisal of a stressor,
rather than merely its severity or duration, largely shapes the physiological response. The process of stress perception, physiological arousal, and coping begins with cognitive appraisal of a stressor. Thus, appraisal may be one of the most important moderators of type of neuroendocrine response to stressors.

Appraisals of threat or challenge carry different information to the brain and thus result in different patterns of both endocrine and sympathetic arousal. Appraisals of threat signify potential for harm or loss, whereas appraisals of challenge represent opportunity for growth or gain (Folkman & Lazarus, 1985; Lazarus & Folkman, 1984). Defeated or threatened responses are characterized by threat appraisals, higher reactive levels of cortisol, and distress, and are usually a response to uncontrollable situations (Lundberg & Frankenhaeuser, 1980; Ursin, Baade, & Levine, 1978; Varnes, Ursin, Darragh, & Lambe, 1982). In contrast, defense responses are characterized by challenge appraisals and signs of the fight-or-flight stress response such as increased blood pressure and heart rate, increased effort, and active coping, usually in response to controllable situations (Frankenhaeuser, 1983; Varnes et al., 1982).

The sympathetic arousal from a defense response is also related to better psychological health and cognitive performance. A high catecholamine increase from rest to stress is related to positive attributes, such as better performance on the challenge (Ellertsen, Johnsen, & Ursin, 1978; Johansson, Frankenhaeuser, & Magnusson, 1973), better emotional adjustment (Rauste-von Wright, von Wright, & Frankenhaeuser, 1981), and lower daily life stress and neuroticism (Forsman, 1981). Thus, elevated catecholamines over a short period may have positive effects on mental and physical functioning. A challenge orientation toward tasks may increase sympathetic reactivity, which increases glucose availability, which in turn enhances performance and ability to cope. In this way, experiencing success from stressors may create a positive cycle of seeking further stressors (viewed as challenges) and benefiting from them (Dienstbier, 1989). Continued exposure to life events may take on a different meaning and function. Stressors may present themselves as opportunities for success and further growth rather than failure (Tedeschi & Calhoun, 1995, p. 32).

Recent research on cognitive appraisal and reactivity, using sensitive methods to assess both parasympathetic and sympathetic arousal, has found that whereas both challenge and threat appraisals can increase autonomic activity, they may do so by different mechanisms. Challenge appraisals are related to increased cardiac output and decreased total peripheral vascular resistance, whereas threat appraisals are related to increased peripheral vascular resistance (Blascovich & Tomaka, 1996; Schneider, 1997; Tomaka, Blascovich, Kelsey, & Leitten, 1993). Given these patterns of reactivity and the underlying sympathetic and parasympathetic mechanisms driving them (peripheral vascular resistance being the only response driven by sympathetic alpha adrenergic receptors), it has been suggested that challenge appraisals lead to parasympathetic inhibition, whereas threat appraisals lead to
enhanced sympathetic activation (Schneider, 1997). This is relevant to our goal of identifying salutary responses to stress. If challenge responses lead to increased reactivity simply through decreasing parasympathetic activity, there are likely fewer catabolic processes accompanying this response than a defeated response driven by higher sympathetic reactivity. As a result, there may be less physical wear and tear from a challenged profile of reactivity and more resilience. Clearly, more research is needed to understand origins and effects of these different profiles of arousal.

Other psychological variables that have been related to lowered stress hormones or enhanced immunity in response to stressors are perceptions of personal competence and control over outcomes, such as self-esteem (Seeman et al., 1995), self-efficacy (Bandura, 1985; Bandura, Reese, & Adams, 1982), and a sense of coherence (Lutgendorf et al., 1998). When given a sense of control over their environment, nursing home residents’ basal cortisol levels dropped dramatically (Rodin, 1980). In work environments, high task demands coupled with high control and autonomy were related to lower basal catecholamines (Karasek, Russell, & Theorell, 1982).

High levels of control, as both a psychological variable (perceived control) as well as a social variable (control over resources), may be a necessary condition for physiological thriving. Without control and resources to cope with daily hassles and larger crises, we are more likely to appraise stimuli as threats to our survival rather than opportunities to grow. Thus, one’s life circumstances and environment, such as poverty, may limit or offer opportunity to develop physical thriving. Social class, one of the largest determinants of health (Adler et al., 1994), may also influence physical thriving. People of higher social class have less chronic stress, more resources, and a greater ability to use organizational and institutional resources (O’Leary & Ickovics, 1995).

Although we are aware of no studies that have directly examined anabolic hormones and social class in humans, we can learn from analogous measures of social status in animals. Socially subordinate baboons have a lower growth index—dramatically lower IGF-1, as well as around 50% higher basal cortisol—than socially dominant ones. Further, longitudinal data suggest that the lower IGF-1 is a consequence rather than correlate of low social rank (Sapolsky & Spencer, 1997). It is not surprising that dominant baboons have greater anabolic functioning than socially subordinate baboons, who have to cope with limited access to resources and less control over their environment. There are many other examples from animal research that subordinate animals have a lower growth index (e.g., higher cortisol, lower testosterone) and other indices of poor health (Blanchard, Sakai, McEwen, Weiss, & Blanchard, 1993; Sapolsky, 1982).

Healthy aging can serve as a global and longitudinal measure of good health and may shed light on factors leading to such thriving. Healthy aging is related to the same psychological variables as our micro measure of health: healthy
Physical Thriving in Response to Stress

hormonal responses. For example, good health in old age is related to high self-esteem (Thomas, 1982), control, power, and decision making (Beckingham & Watt, 1995). Maintaining personal control was a factor common to a subgroup of very old people (81–91 years old) with good health; they tended to live on their own, actively plan and direct their life, and maintain social contacts rather than engage in routine family responsibilities (Neikrug, Ronen, Glanz, & Alon, 1995). Styles of cognitive appraisals have also been related to thriving later in life; in an elderly sample, positive appraisals of loss events were related to high stamina, whereas viewing loss as threatening was related to low levels of stamina (Colerick, 1985). These same psychological constructs—positive appraisals and perceptions of control—also lead to resilient hormone responding and a positive growth index, as previously reviewed. Therefore, we can infer that these psychological factors may lead to enhanced health and longevity in part through influencing endocrine system activity.

Figure 3 integrates the reviewed empirical findings, as well as a theoretical schema, on the pathways from cognitive appraisal and type of stressor to hormonal response to health consequences. Exposure to uncontrollable or chronic stress, or enduring threat appraisals of stressors, can lead to prolonged elevations in cortisol and weakened counterregulatory systems. Over time, this leads to allostatic load and disease. Conversely, exposure to intermittent controllable stressors and psychological factors such as perceptions of control and appraisals of potential for growth can lead to a different cascade of physiological events: short-term increases in catecholamines and, we speculate, strong anabolic counterregulatory responses. These responses may lead to more resilient or toughened stress responding, enhanced allostasis, and physical thriving. We next turn to test one potential measure of physiological thriving: cortisol adaptation to repeated stress.

---

**Fig. 3.** Cognitive appraisal, duration of stressor, neuroendocrine response, and health outcomes.
As a caveat, we must note that frequent exposure to stressors, despite a positive psychological set and apparent physical resilience, may nevertheless have physical costs. Prolonged states of arousal, such as increased blood pressure and heart rate due to challenge perceptions, may still take a toll on physiology; a wealth of research documents the negative impact of general arousal on risk of disease. Thus, the cost of coping with challenge may add up over time. However, new ways to examine specific mechanisms of arousal—such as whether arousal is due to increases in sympathetic or decreases in parasympathetic nervous system activity—may help separate salutary and detrimental effects of positive arousal.

Method

Toward an Empirical Validation of Cortisol Habituation as a Measure of Physical Thriving in Response to Stress

Above, we proposed that psychological thriving should be related to physical thriving, and one form of physical thriving is rapid adaptation to stressors. One way to test this is to examine whether a thriving-related psychological measure—post-stressor psychological growth—is related to a resilient response to laboratory stressors.

We exposed women to a paradigm of repeated (intermittent) lab stress, while we measured their cortisol reactivity, in a study examining stress reactivity. The women were exposed to three consecutive laboratory stress sessions, each lasting 3 hours and starting at the same time in the afternoon, as described elsewhere (Epel et al., 1998). The tasks included solving difficult math and visuospatial problems and delivering a speech. They were initially told the study examined motivation and upon completing the study were fully debriefed about the focus on stress responses. We hypothesized that women who adapted quickly in their cortisol responses to the chronic laboratory stressor would also score higher on a measure of psychological thriving. Thus, we predicted that psychological thriving would be related to a pattern of habituation: high cortisol reactivity on day 1, when most people respond to a novel challenge, and lower cortisol reactivity on days 2 and 3.

Measures

Psychological Thriving. The Posttraumatic Growth Inventory (PTGI; Tedeschi & Calhoun, 1991, 1995; see also Cohen, Cimbolic, Armeli, & Hettler, this issue) is a scale that indicates tendency to thrive psychologically after facing crises. The 21-item questionnaire assesses how much one’s life changed in positive ways as a result of the most stressful event experienced in adult life. The measure has satisfactory test-retest reliability, internal consistency, and discriminant validity. For this sample, four of the five subscales had satisfactory internal consistency: Appre-
Cortisol. Cortisol was measured in two ways: total cortisol response each day and adaptation across days. Total cortisol response for each session was measured as area under the response curve (AUC), in ug/dl*minute. This allowed us to test across participants whether psychological thriving was related to total cortisol secreted on each day.

Cortisol adaptation to stress across days was measured using a coding scheme. Two independent raters compared graphs of the first day of challenge to the two subsequent days of challenge for each individual. Adaptation was coded as habituation if cortisol on stress day 1 was significantly higher than on stress days 2 or 3. Adaptation was coded as nonhabituation if day 2 or 3 cortisol was equal to or higher than that on day 1. A third group, coded as low reactors, showed relatively no change in cortisol between sessions, and their cortisol levels remained low throughout each session (around .10 ug/dl). Reliability of ratings was good (90% agreement between coders).

Statistical analyses. ANOVAs were performed on cortisol response groups and PTGI subscales, as detailed below. Because of the a priori hypotheses, one-tailed p values were used for ANOVAs.

Results

First, correlations were performed between total cortisol secreted each day, as measured by cortisol AUC with the subscales of the PTGI. No relations were found between total cortisol on days 1 or 2 and PTGI. However, on day 3, those with higher cortisol reactivity tended to score lower on PTGI–Appreciation of Life ($r = -.33, p < .05$) and PTGI–Spiritual Change ($r = -.37, p < .01$), supporting our hypothesis that lack of adaptation by day 3 (reflected by high cortisol reactivity on day 3) would be related to lower posttraumatic growth.

To assess adaptation across days within each individual (relative to each individual’s prior cortisol levels), which we regard as the best indicator of one’s cortisol adaptation and thus exposure over time, we used the cortisol adaptation to stress coding scheme described above. Cortisol adaptation was found to be related to two PTGI subscales. Women who did not adapt to the stressors (i.e., showing higher than or equal levels of cortisol on day 2 or 3 compared to day 1, $n = 20$), reported less spiritual growth [$F(2, 57) = 2.49, p = .05$] and less appreciation for life [$F(2, 57) = 2.69, p = .04$] than low reactors. These results confirm the findings using total cortisol secreted (AUC), above, and again support our hypothesis that psychological adaptation is related to physiological adaptation.
To view this relationship graphically across days, we examined, as an example, women in the highest and lowest tertiles on spiritual growth. As shown in Figure 4, there were large differences in reactivity over time between PTGI groups. Women highest on spiritual growth tended to have similar cortisol levels to those of women low on spiritual growth on day 1, when first exposed to the stressors. However, by days 2 and 3, these women adapted to the stress, whereas women low on these subscales remained high in cortisol reactivity.

Fig. 4. Cortisol response curves each session among high- and low-scoring women on posttrauma spiritual growth.
Discussion

Women who quickly adapted to the repeated laboratory stressors were more likely to report thriving in response to previous traumatic stress. Specifically, these women came away from their largest life trauma with a greater appreciation of life (e.g., appreciation of each day, changed priorities) and stronger religious faith. Their cortisol adaptation may reflect different psychological and/or physiological processes. They may have coped with the lab stressors more efficiently, reflecting more facile adaptation to life stressors in general. We could also speculate that these women may have experienced physiological eustress, or a toughening up from their past traumas.

These results offer preliminary support to the micro-level measure of cortisol habituation as an index of thriving. Cortisol habituation to repeated stressors may reflect more robust psychological adaptation. Physiologically, it may represent a tighter allostatic system and greater flexibility in the hypothalamic-pituitary-adrenal axis—greater ability to shift from arousal to baseline. The results underscore the importance of individual responses to life stressors in determining salutary physiological responses. Greater ability to predict individual responses to stress will greatly increase our understanding of both disease and robust health.

We must note that cortisol habituation to stress was related to only two of four psychological thriving subscales assessed, which increases the possibility that our findings were by chance. It is also possible that given the nature of the laboratory stressors—achievement tasks with somewhat uncontrollable outcomes—the relevant growth measures were these more positive global views of life (appreciating situations in life, placing control in a higher power) that one may take comfort in. Scoring high on spiritual growth represents one of the highest order constructs of posttraumatic growth. Greater spiritual belief may reflect successful resolution of past trauma and the paradox of gaining control over one’s life by giving up control or handing it over to a higher power (Tedeschi & Calhoun, 1995, p. 38). In this way, subsequent life events may become more meaningful (Tedeschi & Calhoun, 1995) and less stressful, especially when they are uncontrollable.

These results call for replication with a sample more representative of the general population and with naturalistic stressors. Nevertheless, we present this study as an example of those needed to understand further how higher order psychological constructs may positively affect health. The study also serves as an example of ways to operationalize types of psychological and physical thriving.

General Conclusions

We have reviewed pathways to physical thriving, such as relaxation and toughening up through repeated exposure to short-term stressors. Exposure to manageable stressors can leave one’s stress response systems more resilient than before.
Most relevant to this *Journal* issue is that psychosocial and cognitive factors, such as challenge appraisals (in contrast to threat appraisals), high self-esteem, control over resources, and perceptions of control over one’s environment, can moderate responses to stressors, leading to salutary neuroendocrine responses. Further, we have suggested that exposure to stressors and effective coping responses are actually necessary for physical thriving. We have argued that the biochemical analogs of perceived positive arousal and relaxation promote growth and efficient allostasis: tight counterregulatory neuroendocrine response systems. Conversely, perceptions of threat or loss shift one’s physiology toward negative stress arousal: a catabolic state that inhibits growth and restorative functioning and increases allostatic load and disease.

Whereas much animal research is finding that uncontrollable stress and social defeat can lead to disease and death, research on humans is more complex. Perceived loss of control may lead to loss of homeostatic control over metabolism, immune functioning, and growth. Clearly, more research is needed to understand how responses to stress can lead to growth and thriving versus disease and death. As a small step toward this goal, we have presented data showing that women high on a measure of psychological thriving responded to a repeated laboratory stressor with rapid cortisol habituation. These psychologically hardy women demonstrated greater flexibility in their hypothalamic-pituitary-adrenal axis, a sign of efficient allostatic regulation and positive health. To deepen our understanding of thriving, future research should also measure one’s growth index—the ratio of anabolic and catabolic processes in response to challenge—as well as psychological measures of growth, relaxation, positive states, and well being.

**References**


ELISSA EPEL is currently a clinical intern at the Palo Alto Veterans Hospital. She has completed the Ph.D. requirements in clinical psychology at Yale University. Her current research interests focus on psychoneuroendocrine profiles that predict healing or disease processes. The data reported here were part of her dissertation.
on cortisol, stress, coping, and body fat distribution, which was funded by the MacArthur Foundation Working Group on Socioeconomic Status and Health. Epel was the recipient of the APA Division 38 Student Research Award and the Society of Behavioral Medicine’s Outstanding Dissertation Award.

BRUCE MCEWEN, a neuroscientist, is Professor and Head of the Harold and Margaret Milliken Hatch Laboratory of Neuroendocrinology at Rockefeller University, where he also received his Ph.D. He has served as Dean of Graduate Studies and is an editorial board member of numerous journals in his field as well as Past-President of the Society for Neuroscience and a member of the National Academy of Sciences. He has more than 600 publications dealing with the effects of stress and sex hormones on brain functions. He has shown that gene expression can be regulated by the endocrine system, and has elucidated the effects of steroid hormones at molecular, cellular, and organismic levels. His work spans the social/psychological to the molecular level, and continues to have great impact on many fields, as well as important clinical implications.

JEANNETTE R. ICKOVICS is an Assistant Professor of Epidemiology and Public Health and of Psychology at Yale University. She received her Ph.D. in Applied Social Psychology from the George Washington University. Her research focuses on women and HIV/AIDS as well as more generally on the interaction of biomedical and psychosocial factors that promote good health and recovery. She received a Scholar Award from the American Foundation for AIDS Research (1993–1996), as well as the 1991 Distinguished Publication Award from the Association for Women in Psychology. She was the SPSSI Program Chair for the 1995 APA convention and served on its council from 1995 to 1997.