

# The Handbook of Stress Science

Biology, Psychology, and Health

Editors

Richard J. Contrada

Andrew Baum

---

*The Handbook of*  
**Stress Science:**  
**Biology, Psychology, and Health**

---

*The Handbook of*  
**Stress Science:**  
**Biology, Psychology, and Health**

---

*Editors*

Richard J. Contrada, PhD

Andrew Baum, PhD



# 1

## Stress, Adaptation, and Health

---

*Richard J. Contrada*

Stress is the topic of extensive and diverse literatures in social, behavioral, and life sciences. The broad scope and multidisciplinary usage of the term *stress* are among the considerations that have led some to suggest that it can usefully serve only as a general rubric for a set of loosely related research areas, and that it is ill-suited as a label for any single concept with any one particular technical definition. Others, by contrast, have offered quite narrow, discipline-specific definitions of stress. Still others, pointing to problems with definitions and other sources of dissatisfaction with stress research, have argued that the stress concept should be abandoned. Among those favoring retention of *stress* as a meaningful scientific concept, one often finds a position, intermediate to the very broad and very narrow views, in which there is an attempt to specify the essence of *stress* that remains constant across varied applications of the term. In one example of the latter approach, stress is defined as “a process in which *environmental demands tax or exceed the adaptive capacity of an organism, resulting in psychological and biological changes that may place persons at risk for disease*” (Cohen, Kessler, & Gordon, 1997, p. 3, emphasis in original).

Middle-ground definitions of stress such as that of Cohen et al. (1997) contain several key elements. One of these is the inclusion of environmental, psychological, and biological phenomena, which incorporates three distinct traditions that can be traced back through the history of stress research. A second is a focus on process, which contrasts with some earlier views in which *stress* is a more static construct, referring, for example, to a stimulus or a response. A third aspect of this definition, the idea of an imbalance between environmental demands and adaptive capacity, suggests a person–situation interaction that causes a departure from homeostasis and activates compensatory psychological and biological activity. Fourth, although stress has been studied in relation to many different kinds of consequences, this definition recognizes that much interest in stress among scientists and lay persons alike lies in its potential role in the development and control of health problems, particularly those involving physical disease.

Environmental, psychological, and biological traditions, and approaches in which these paradigms have

been effectively integrated, have provided a strong foundation for an active, productive, and cumulative field of health-related stress science. The importance of stress concepts and associated research methodologies is nowhere more salient than it is in the fields of health psychology and behavioral medicine. Many social and psychological variables of interest as possible risk or protective factors in the development of physical disease are themselves conceptualized as forms, aspects, or consequences of stress, or are seen as stress moderators that exert their health effects by amplifying or dampening stress-related processes. Moreover, the central nervous system, neuroendocrine, and autonomic changes that have been identified as components of the biological stress response have been linked to alterations in cardiovascular, immunological, and other physiological systems whose dysregulation has been implicated in a wide variety of physical health problems. Additionally, there is growing recognition that stress is associated with behavioral processes, including eating, drug use, and illness management, that form indirect pathways to disease outcomes. It also appears that cognitive and behavioral interventions can reduce stress and thereby improve physical health.

Just as stress science has informed our understanding of health problems, the study of physical health and disease has been a useful arena in which to develop, test, and refine conceptions of stress. Stress is an essential topic within the larger set of basic sciences that are aimed at uncovering the fundamental principles of human psychology and biology. To characterize the negative health consequences of stress, and the processes through which they develop, is to describe the operating features of the evolved machinery of the human mind, brain, and body, and to begin to understand how that machinery interacts with the physical and sociocultural environment. Beyond that, the identification of a role for stress in problems of physical health and disease underscores the practical importance of both basic and applied stress research. It is therefore the premise of this *Handbook* that much is to be gained by taking stock of conceptual developments, empirical findings, clinical applications, and investigative strategies and tools that have accumulated over the past few decades of stress research, a time period that has seen a burgeoning of health-related stress science.

The purpose of this chapter is to set the stage for the chapters that follow. It begins by discussing some of the definitional problems alluded to above. It then describes a set of themes and developments that characterize the field of health-related stress research as it has unfolded over the past few decades. This is followed by a discussion of some of the main challenges that are faced by researchers seeking to further our knowledge of the role of stress in the development and control of physical disease. Next, the structure of the *Handbook* is outlined, and some of its limitations are enumerated. A concluding comment conveys our expectations for the use and impact of this volume and for the further scientific study of stress.

## DEFINING STRESS

Debates about how to define stress are long-standing and highly nuanced. Fortunately, they have had little apparent effect, if any, in inhibiting progress in the field. Although a detailed discussion of the issues will not be attempted here, an overview of selected highlights may be worthwhile. Below we briefly discuss the problems of *circularity*, *fuzziness*, and *probabilistic causation*.

### CIRCULARITY

It is difficult to imagine the field arriving at a broad consensus in favor of a stimulus-based definition in which *stress* corresponds solely to a particular set of specific kinds of environmental events or conditions. But, if that were to occur, *stress* (or *stressors*) might be defined as a list with elements such as bereavement, war, terrorism, and the like. One problem with this scenario is the likelihood of definitional overinclusiveness, that is, there may be individuals who experience bereavement or war but do not show the hypothesized effects of stressor exposure. This would run counter to connotations of the term *stressor* in which a measureable psychological and biological impact is expected and, definitions aside, it would diminish the predictive value of such a stress concept. At the same time, it is likely that such a definition would also be too restrictive, omitting events and conditions that are often, though not always, *stressful*, such as a divorce or a demanding job. Based on common usage, one naturally looks to the consequences of events/conditions that purportedly operate as stressors for evidence that this is indeed the case. This leads to dissatisfaction because it goes beyond the bounds of a stimulus definition, entailing as it does a consideration of stress responses, and because it asserts causal effects of stressors, an empirical matter, as true by definition.

Similar problems arise from response-based definitions of stress. Alterations in endocrine and autonomic activity might form parts of such a definition, but if

those physiological changes are produced by engaging in sexual activity or viewing a tennis match, the point of the definition will be seen to have been lost by many stress researchers. Excluding some stress response episodes from the definition, or distinguishing between *good* and *bad* forms of stress based on the nature of the eliciting stimuli, would, again, involve circularity, since a response-based definition should not entail stimulus considerations or presume hypothesized causes. Thus, stimulus-focused conceptions of stress appear inadequate, as do response-focused ones, with attention to both stimulus and response needed in order to maintain contact with many phenomena of interest, to exclude irrelevant topics, and to generate accurate predictions. This issue was apparently of concern to Hans Selye, whose work had an enormous impact in popularizing the study of stress. He originally defined stress in terms of stimuli, before shifting to a response-based definition with his concept of a *general adaptation syndrome* (Selye, 1956). The issue also figured into John Mason's subsequent critique of the revised, response-based approach (Mason, 1975a, 1975b).

### FUZZINESS

A certain amount of imprecision is to be expected in defining constructs, especially in the early going and when those constructs are burdened with the role of representing complex social, psychological, and biological phenomena. Thus, formulations that avoid the limitations of stimulus- and response-focused approaches, by defining stress in terms of processes (i.e., whereby certain kinds of stimuli lead to certain kinds of responses), will leave something to be desired as regards precision and specificity, until those processes are clearly and thoroughly characterized. In a way, the problem may appear to become worse, rather than better, as progress is made.

For example, difficulties in specifying general rules regarding the effects of *stressful* stimuli on *stress* responses were addressed in a theoretical synthesis described by Richard S. Lazarus. In what is nearly universally regarded as a major psychological contribution to understanding stress, Lazarus argued that the concepts of cognitive appraisal and coping are required in order to explain how exposure to certain kinds of (stressful) events and conditions leads to certain kinds of (stress) responses, and to account for individual differences in those responses (Lazarus & Folkman, 1984). Although it is hard to deny that the appraisal and coping concepts have proved at least somewhat useful, they also have their limitations. One is that, as defined, it is difficult to tease them apart, either conceptually or operationally. That is, it is hard to say where the cognitive-evaluative (appraisal) process that initiates stress terminates, and where the coping activity whereby the person manages the perceived stressor and its effects, and which invariably has a

cognitive component, begins. Consequently, it is difficult to obtain a measure that reflects cognitive appraisal but is independent of coping. Other problems arise in distinguishing among stressful stimuli, other social-contextual factors, and personal dispositions, and in separating appraisal and coping from other responses to stressors. Thus, although both appraisal and coping constructs appear necessary, and are widely accepted, they are certainly not without their critics, for reasons that include (though by no means are limited to) issues of fuzziness and conceptual and measurement-level overlap (e.g., Coyne & Racioppo, 2000; Dohrenwend & ShROUT, 1985).

### PROBABILISTIC CAUSATION

It has been suggested that definitional problems with the stress concept have contributed to its inability to provide a basis for acquiring adequate empirical support for a priori statements as to what kinds of stimuli will provoke stress responses and which bodily systems will respond (e.g., Engel, 1998). However, this criticism may be countered, as it is in many areas of inquiry, by recognizing that elements of the processes involved in stress show probabilistic, rather than deterministic causal relationships with one another. Much of the progress that has been made in the stress field has resulted from extending the stress-coping framework by incorporating additional constructs to improve predictive precision. Thus, stressors are not inherently stressful, they are events and conditions that are *potentially* stressful (i.e., that *may* produce predicted responses) depending upon cognitive appraisal and coping processes. The outcomes of those appraisal and coping processes, in turn, depend upon personal attributes and social-contextual factors that operate as resources or vulnerabilities, either dampening or amplifying the stress response (at least in part) through their effects on appraisal and coping. Better understanding of appraisal and coping, further identification of resource/vulnerability factors, and more detailed characterizations of the processes of interplay linking appraisal and coping to resources and vulnerabilities, have increased the precision of predictions regarding the occurrence and outcomes of stress.

### THEMES AND DEVELOPMENTS

Overall, research concerning stress and health has shown increased differentiation over the past few decades, more closely approximating the complexity of the phenomena it seeks to understand. This can be seen in a number of different developments. In the next few sections, we highlight several of these, which include increased emphasis of *cognition*, *multilevel analysis*, greater attention to *pattern-ing in stress phenomena*, more sophisticated *measurement models*, more *dynamic process models*, and increased specificity in modeling *disease-promoting mechanisms*.

### COGNITION

Lazarus's first studies of the appraisal process (e.g., Lazarus & Alfert, 1964), and criticisms of Selye's (1956) stress model in which Mason emphasized the role of perceptual processes as the initiating event in stress (Mason, 1975a, 1975b), were among the early observations that foreshadowed contemporary views in which the role of cognition is central to understanding the provocation of psychological stress, coping, and other adaptive responses that ensue. Also important in this regard was Glass and Singer's (1972) programmatic examination of the role of perceived predictability and controllability in the behavioral and physiological impact of urban stressors, and Leventhal's theoretical work concerning the influences of cognitive representations of health threats on the management of chronic disease (Leventhal, Meyer, & Nerenz, 1980). Notwithstanding the importance of stress processes that arise from noncognitive sources (e.g., systemic stress responses stimulated by activity of proinflammatory cytokines), a cognitive perspective now dominates in research concerning the initiation of stress.

It follows that a cognitive perspective also guides a considerable amount of work focused on coping and other forms of adaptation to stressors. Thus, the selection and execution of coping responses are viewed as processes that are shaped by cognitive appraisal. For example, a stressor that is perceived to be potentially controllable will more likely instigate active, problem-focused coping activity than one that appears uncontrollable and therefore unlikely to be responsive to such efforts. Moreover, many specific forms of coping activity themselves involve cognitive processes, such as attention, interpretation/reinterpretation, meaning making, and cognitive approach and avoidance (Carver, chapter 17).

The impact of major moderators of the stress-coping process is also frequently construed in cognitive terms. For example, effects of social support often depend upon how social resources are *perceived* (e.g., Sarason, Sarason, Potter, & Antoni, 1985) and, among personality factors influencing the stress-coping process, much attention has been given to those that involve *expectancies*, such as dispositional optimism (e.g., Scheier, Carver, & Bridges, 1994) and locus of control (e.g., Bollini, Walker, Hamann, & Kestler, 2004); *attributions*, such as explanatory style (e.g., Jackson, Sellers, & Peterson, 2002); *information-related preferences*, such as monitoring-blunting (e.g., Hoffner, 1993); and *beliefs*, such as cynicism and mistrust (e.g., Williams, Smith, Gunn, & Uchino, chapter 18). In stress-reduction research, *cognitive-behavioral* interventions have produced positive effects on both psychological and biological outcomes in patients with various chronic medical conditions (see chapters in this volume by Baum, Trevino, & Dougall; Nezu, Nezu, & Xanthopoulos; and Perez, Cruess, & Kalichman).

## MULTILEVEL ANALYSIS

Stress research has progressed to a point where it stretches *from cells to society*, to use what is perhaps a hokey but nonetheless appropriate catch phrase. A psychological level of analysis that focuses on the individual person has been extended *downward* to basic processes at the cellular and molecular levels, as well as *upward* to the levels of the dyad, group, organization, and larger society (Norman, DeVries, Cacioppo, & Berntson, chapter 43). This can be seen as a product of the capacity for psychology to serve as a *hub* science in relation to neighboring fields of inquiry (Cacioppo, 2007). It also reflects the increasing permeability of traditional disciplinary boundaries that has characterized the health sciences in the past few decades (Leiderman & Shapiro, 1964; Schwartz & Weiss, 1978).

One sense in which interactions of factors at different levels of analysis have long been a focus of stress research is the emphasis noted above on the cognitive elicitation of biological stress responses. In contemporary, health-focused stress research, this form of *psychophysiological* cross-level analysis has been greatly extended, reaching both upward and downward to still higher and lower levels of analysis. This follows from the identification of biological stress responses with a category of disease-promoting mechanisms through which social, psychological, and behavioral factors influence the etiology and pathogenesis of physical disorders, which ultimately involve alteration of the structure and functioning of bodily systems, organs, and cells. Thus, for example, one can trace the influence of global human activity (international trade) and associated historical events (enslavement and transport of Africans to the United States) on the emergence of sociocultural factors (institutional racism) that have led, in turn, to social psychological phenomena (individual-level prejudice, stereotyping, and discrimination) whose psychological impact (race-related stress) may promote cardiovascular diseases involving damage to the heart that can be observed under a microscope (myocardial hypertrophy).

In addition to efforts aimed at tracing the flow of events *downward* from macrolevel social-environmental forces through midlevel psychological factors to microlevel disease processes, developments in stress science over the past few decades have involved other forms of multilevel analysis. As in many areas of psychological research, the understanding of stress-related phenomena has been enhanced in work that has sought to integrate neurobiological analysis with analysis of cognitive, social, and affective processes. Salient examples include characterization of the biology of threat perception, emotional memory, and conditioning (LeDoux, 1996); the genetic (McCaffery, chapter 6) and central nervous system processes (Dallman & Hellhammer, and Gianaros & O'Connor, chapters 2 and 39) underlying initiation of peripheral physiological stress responses; influences of oxytocin and opioid mechanisms on nurturing and affiliative behaviors promoted by stress

and their possible role in promoting social support processes (Taylor & Master, chapter 8); immunological influences on emotional behavior (Hash-Converse & Kusnecov, chapter 5); and the neurobiology of health-related personality factors (Williams et al., chapter 18).

## PATTERNING

The foundational contributions to the stress field of Walter B. Cannon (1929) and Hans Selye (1956) involved the discovery of biological response patterns, namely *fight-or-flight* and the *general adaptation syndrome*. In the time since, and especially in the last few decades, additional stress response pattern constructs have been introduced. In some cases, these refer to individual differences and/or cross-situational variations in the activity of a physiological response system; one example is the observation that cardiovascular adjustments to behavioral stressors may involve a largely myocardial response, a largely vascular response, or a mixture of the two (Burg & Pickering, chapter 3). In other cases, patterns have been described in terms of responses that are integrated across multiple systems. Examples include the *tend-and-befriend* response (Taylor & Master, chapter 8), characterized both in terms of patterns of nurturing and affiliative behaviors that underlie health-promoting effects of social support processes (Uchino & Birmingham, chapter 9) and their neural and neuroendocrine underpinnings. Another is *sickness behavior*, defined with reference to a syndrome of behaviors including anhedonia, aphagia, and fatigue and underlying immune system processes including central nervous system effects of proinflammatory cytokines (Hash-Converse & Kusnecov, chapter 5).

Patterning has also figured into developments in thinking about psychological eliciting and response processes in stress. Advances in theory regarding the role of appraisal in psychological stress have been made by drawing upon emotion research, thereby extending earlier conceptions in which stressful appraisals were limited to threat, harm/loss, and challenge. Stress may be better understood as arising from a larger set of more complex appraisal patterns, such as have been described in accounts of qualitatively distinct basic emotions such as fear, anger, and sadness (e.g., Lazarus, 1991; Smith & Kirby, chapter 15). Similarly, distinctions between different patterns of coping activity, initially confined to that between its problem-focused and emotion-focused forms, have been the subject of efforts to provide a more complete and nuanced coping framework (Carver, chapter 17). These include the identification of coping patterns that appear most likely to be accompanied by health-damaging physiological activity, such as vigorous efforts to master potentially uncontrollable stressors (Glass, 1977), and coping patterns that are directly damaging to health, such as the use of nicotine, alcohol, and other substances (Grunberg, Berger, & Hamilton, chapter 22). Similarly, research on adaptation to



threatening medical diagnoses and treatments has identified coping patterns of potentially broad relevance to multiple forms of stress, such as in the work of Taylor (1983) on processes of adjustment in cancer patients that entail a search for meaning, attempts to regain mastery, and efforts to restore self-esteem. Self-management of chronic medical conditions also can be seen as a pattern of coping activity that is guided by illness-related belief patterns and directed toward a health-related stressor (Garrido, Hash-Converse, Leventhal, & Leventhal, chapter 35).

## MEASUREMENT MODELS

Newly identified forms of patterning in stress elicitation and response processes have major implications for measurement tools. Studies involving the assessment of a single dimension of stressor exposure and a single dimension of stress response are increasingly giving over to studies that make use of multidimensional assessments of both stressor and stress response. For example, in research on stressful life events, instruments have been developed that differentiate major life stressors, stressful events that occur on a daily basis, and the unfolding of stressful encounters during the course of a given day (see chapters in this volume by Anderson, Wethington, & Kamarck; Almeida, Stawski, & Cichy; and Kamarck, Shiffman, & Wethington). In addition, the relevant assessment tools and associated statistical techniques make it possible to tease apart multiple features of the stressor, of cognitive and affective responses to the stressor, and of coping behaviors. Moreover, they also provide a means of relating these stress process components to psychosocial risk and vulnerability factors that characterize the individuals confronting the stressor, and the social context in which this occurs, often in a way that integrates both between- and within-person levels of analysis.

Assessment of psychosocial moderators of stress processes also has been guided by more sophisticated measurement models. For example, the measurement of exchanges within social networks now distinguishes between beneficial and detrimental forms of each of support, companionship, and control (Rook, August, & Sorkin, chapter 10). Social support is further differentiated into multiple forms, including those referring to the types of support that may be available, and to the types that are received, and relationships with social network members are characterized in terms of separable dimensions of negativity and positivity. The latter development draws attention to the problem of ambivalent social ties, which may pose even more serious difficulties than those arising from simple negativity (Uchino & Birmingham, chapter 9). Greater attention to the independence of positive and negative psychological phenomena is also seen in the assessment of emotional responses that accompany stress, where, for example, there have been efforts to model the conditions under which these dimensions remain largely uncorrelated

and define a two-dimensional space, and when they collapse into a single, bipolar dimension (Finan, Zautra, & Wershba, chapter 16).

At a biological level, there appears to be an ever-growing array of structures and processes that are activated by stress. From the central nervous system circuits that mediate stressor appraisal and initiate peripheral physiological manifestations of stress (Dallman & Hellhammer, and Gianaros & O'Connor, chapters 2 and 39), to the neural hormones and peptides involved in social behavioral responses to stressors (Taylor & Master, chapter 8), to the immune/inflammatory (Dhabhar, and Hash-Converse & Kusnecov, chapters 4 and 5), genetic (McCaffery, chapter 6), and molecular (Baum, Lorduy, & Jenkins, chapter 7) effects and moderators of stressor exposure, theoretical and technical advances have had a major impact in expanding the set of measurable biological parameters that are accessible to stress researchers.

In addition to newly emerged biological stress indices, there have been significant improvements in the assessment of more traditional ones. For example, classic stress hormones, such as cortisol and the catecholamines, epinephrine and norepinephrine, are amenable to increasingly precise measurements based on an expanded set of sources (e.g., blood, urine, saliva) that suit different research questions and satisfy various practical considerations (Lundberg, this volume). In addition, examination of temporal patterning has enhanced the breadth and resolving power of measurements involving both traditional stress hormones (Lundberg, chapter 38) and cardiovascular parameters (Christie, Jennings, & Egizio, chapter 37).

## DYNAMIC PROCESS MODELS

Greater use of multilevel analysis and growing numbers of elicitation and response patterning concepts have revealed some limitations in traditional views of stress processes. As a consequence, work in the past few decades has made use of increasingly more complex and sophisticated theoretical modeling. In many instances these models are also more dynamic in the sense of emphasizing processes of change, multidirectional influences, and systems-level as opposed to variable-focused conceptualizations.

One salient example may be found in discussions of basic principles of stress physiology (Berntson & Cacioppo, 2007; Norman et al., chapter 43). Contemporary views of this topic have been strongly influenced by the concept of *homeostasis*, a term coined by Cannon (1929) to capture and extend Claude Bernard's observations regarding the processes whereby constancy is maintained in the internal environment (*milieu intérieur*) of organisms in response to its threatened disruption. More recently, alternative concepts have been suggested as a means of updating Cannon's view to give more explicit recognition to the complexities and dynamism of homeostatic regulation. For example, Sterling and Eyer (1988) introduced the term

*allostasis* to incorporate the notion that physiological regulation is guided by changing, rather than fixed, set-points, and to capture the idea that higher neural centers may regulate a wide range of systems to achieve control of a particular function. This view of allostasis or *stability through change* has been extended by McEwen and Wingfield (2003, 2010), who describe processes whereby exposure to stressors may create *allostatic load* (the cumulative cost to the body of allostasis) and eventually lead to *allostatic overload* (a state in which serious pathophysiology can occur). Others have proposed somewhat different frameworks in attempting to formulate more dynamic models of stress physiology (e.g., Berntson & Cacioppo, 2007; Norman et al., chapter 43; Romero, Dickens, & Cyr, 2009).

More dynamic models also have been found to be useful in accounting for social and psychological aspects of stress. Increasingly, personality and social relationship factors thought to influence stress processes have been conceptualized in ways that allow for multiple forms of interplay between stressor, social context, and personality attribute (Betensky, Glass, & Contrada, in press; Williams et al., chapter 18). Bidirectional influences are also seen in frameworks for understanding stress in particular contexts, such as the workplace (Pandey, Quick, Rossi, Nelson, & Martin, chapter 11) and other organizational settings (Weinberg & Cooper, chapter 12). Similarly, race- and ethnicity-related maltreatment has been modeled in terms that explicitly address interactions between institutional and environmental factors and individual-level discrimination (Brondolo, Brady, Libby, & Pencille, chapter 13).

## DISEASE-PROMOTING MECHANISMS

Although Cannon did not refer to *stress* frequently in his writings, he did express the belief that stress would eventually become an important concept in understanding and treating medical problems (Cannon, 1928). Selye (1956) impressed upon the stress field the idea that *wear and tear* produced by repeated activation of the general adaptation syndrome was a contributing factor in the development of physical disease. The emergence of the fields of health psychology and behavioral medicine was associated with general recognition of the role of stress in mechanisms through which psychological and behavioral factors influence physical health outcomes (Krantz, Glass, Contrada, & Miller, 1981). At about the same time, evidence linking the Type A pattern to coronary heart disease (CHD) became a major impetus for research evaluating the hypothesis that stress-induced elevations in cardiovascular activity and underlying hormonal and autonomic changes contribute to the initiation and progression of coronary atherosclerosis and the precipitation of clinical CHD (Krantz & Manuck, 1984). One important product of this research was the development of a paradigm that integrated *epidemiological* findings regarding the relationship of Type

A behavior to CHD with a *stress-coping* framework containing an explicit *mechanistic* component (Glass, 1977). In that framework, Type A behavior represents a pattern of coping with potentially uncontrollable stressors that is accompanied by elevations in circulating catecholamine levels and cardiovascular activity, markers for processes that may culminate in CHD outcomes.

In the years since, increasingly detailed models of the relationship between biological stress responses and negative health outcomes have been advanced. The birth and maturation of the field of psychoneuroimmunology reflect steadily accumulating knowledge regarding the complex relationships between stress and immune function (Dhabhar, chapter 4), and these relationships may be involved in pathways linking stress to infectious diseases (Pedersen, Bovbjerg, & Zachariae, chapter 31), cancers (Baum, Trevino, & Dougall, chapter 30), and CHD (Bekkouche, Holmes, Whittaker, & Krantz, chapter 28). In addition to recent findings concerning stress-related immune and inflammatory processes, mechanism-focused research on CHD has in other ways extended well beyond measures of acute changes in blood pressure and heart rate, to include, for example, assessments of vascular activity, endothelial dysfunction, and blood platelet aggregation (Burg & Pickering, and Bekkouche et al., chapters 3 and 28). Still another development of note in the cardiovascular area is the incorporation into stress research paradigms of intermediate and sub-clinical disease markers, such as cardiometabolic syndrome (Brooks, McCabe, & Schneiderman, chapter 29), and nonfatal clinical markers, such as stress-induced myocardial ischemia (Bekkouche et al., chapter 28). In this regard, Bekkouche et al. outline a model that links specific pathogenic stress responses to a series of time points in the natural history of CHD, from effects of stress on traditional CHD risk factors such as resting blood pressure and lipid levels in healthy individuals, to the provocation of malignant cardiac arrhythmias in coronary patients exposed to stressors. Finally, the search for specificity in the identification and characterization of stress-related biological mechanisms culminating in physical disease may be undergoing a transformative expansion in its extension to cellular and molecular processes, including those involving effects of oxidative stress on DNA damage and repair that have possible implications for carcinogenesis (Baum, Lorduy, & Jenkins, chapter 7), and changes in endothelial function that may be involved in the pathogenesis of CHD (Burg & Pickering, chapter 3).

Although the study of stress traditionally has emphasized its direct biological effects as a pathway to disease, the role of stress in psychological and behavioral processes that promote physical health problems is receiving increased attention. These include substance use, eating patterns, and a sedentary lifestyle, which may promote chronic diseases in healthy individuals (see chapters in this volume by Grunberg et al.; O'Connor & Conner;

and Edenfield & Blumenthal). They also include perceptual, cognitive, and behavioral processes involved in the patient's efforts to understand and manage chronic medical conditions (Garrido et al., chapter 35). Thus, although direct psychophysiological effects of stress, behavioral effects of stress, and reactions to illness are usefully distinguished as three general forms of disease-promoting mechanisms (Krantz et al., 1981), and while health-related behaviors are often treated as potential confounds in research linking stress to disease outcomes, interactions and areas of overlap among these three sets of mechanisms have become increasingly evident and, appropriately, have come to form the subject of more integrative examination in research on stress and health.

## CHALLENGES

Although there has been significant progress in health-related stress research, enormous challenges remain. Concerns about definitions of the term *stress* are not entirely without substance. Even casual perusal of this *Handbook* will reveal nontrivial variations in how authors prefer to conceptualize stress, distinguished in some cases by a preference for either a primarily environmental, psychological, or biological formulation. It also will raise questions about the unique and common elements of *psychological stress*, *psychosocial stress*, *interpersonal stress*, *systemic stress*, *restraint stress*, *rotation stress*, *cognitive stress*, and *emotional stress*, to list just some of the many *stress* phrases that stress researchers find necessary. The demand for unity or at least a greater degree of conceptual cohesiveness has its counterpart at the level of measurement. It is nearly inconceivable that a single measure or measurement battery will ever be devised to make possible an assessment of stress that would be equally useful for the wide variety of research questions and clinical applications in which stress appears to play a central role. In many ways, a full picture of the biological stress response is only beginning to take shape, and much the same can be said of its environmental and psychological antecedents, on the one hand, and the pathways through which stress promotes mental and physical health problems, on the other. Similarly, the operation of social and personal risk and protective factors that appear to moderate stress processes are much more often described in terms of statistical interactions or boxes and arrows rather than with regard to substantive processes of interaction. Psychological interventions can reduce stress and in some cases have exerted a positive impact on health outcomes, but it remains to be seen whether stress reduction can make a significant contribution in controlling the major sources of morbidity and mortality and their associated direct and indirect economic costs. As the chapters in this volume attest, major advances have been made in response to these and other challenges, but much more needs to be done.

## ORGANIZATION OF THE HANDBOOK

This *Handbook* is composed of five sections. Section I reviews current knowledge regarding the major biological structures and systems that are involved in the stress response. A chapter on central, neuroendocrine, and autonomic mediation of stress-related physiological and behavioral activity is followed by treatments of the interplay of those initiating processes with cardiovascular and immunological processes. These updates on traditional topics of stress biology are accompanied by discussions of more recently emerging literatures concerning immunological and genetic modulation of stress responses and effects of stress that are observable at the molecular level.

Section II covers social-contextual contributions to stress and to processes of adaptation to stress. It begins with a discussion of the tendency of humans to form relationships and provide one another with support in response to life stress as an evolved biological adaptation traceable to mammalian evolution. This is followed by psychological and sociological treatments of the structure and function of social relationships as they relate to stress and support processes. A series of chapters then discuss stress and its consequences in the context of the workplace, organizations, race and ethnicity, and the socioeconomic spectrum.

Section III is concerned with psychological factors in stress. It begins with a theoretical review and update of the concept of cognitive appraisal as it relates to stress and emotion, with particular reference to the potential for appraisal constructs to integrate and extend these two fields of study. Research on emotion is then subjected to further discussion as a way of expanding the more traditional psychological stress perspective. The next chapter is on coping, another concept that is fundamental to psychological perspectives on stress. Stress and coping are then discussed in relation to personality, gender, and adult development.

Section IV provides reviews of the evidence linking stress to health-related behaviors and mental and physical health outcomes. Eating and drug use are discussed as behaviors that are to some extent driven by stress, and physical exercise is considered as a behavioral means of reducing stress and its health effects. Stress is then examined as a factor in pregnancy and childbirth outcomes, and in relation to depression and childhood and adolescent mental health problems. The remaining chapters focus on physical health outcomes. First, traumatic stress is examined as a contributor to a variety of physical health problems. Successive chapters then focus on specific medical conditions: cardiovascular diseases, cardiometabolic syndrome, the cancers, infectious diseases, and HIV/AIDS. Subsequent chapters consider the relationship between stress and pain, interventions for reducing stress in chronically ill patients, and the role of stress in the management of chronic illnesses.

Section V covers research methods, tools, and strategies. It begins with a review of the principles and

techniques of laboratory experimentation in stress research. Following are chapters that detail methods for the use of cardiovascular and neuroendocrine measures. The next chapter discusses the recent introduction of brain imaging to stress research. Three chapters then provide reviews and updates on tools for the self-report assessment of environmental stress. The final chapter discusses multilevel analysis as an overarching strategy for research on stress and health.

## SOME LIMITATIONS

This *Handbook* does not provide comprehensive coverage of the field of stress science, nor was it intended to. Its size and scope did expand as we enumerated topics and enlisted authors, and this enabled us to cover more territory. Nonetheless, the resulting set of chapters is representative, but not exhaustive, in covering the major areas of stress research that are concerned with psychological and biological processes whereby stressful environmental events and conditions promote health problems. It is clearly more than an arbitrary sampling of those topics but, at the same time, it is a less than encyclopedic collection.

Even within its intended scope, there are several topics that might have been represented by adding chapters but, because of limited space and various other practical reasons, this could not be done. Among these are additional biological systems (e.g., respiration, digestion), life functions (e.g., sleep), and physical conditions (e.g., rheumatoid arthritis, irritable bowel syndrome) that may be influenced by stress. A review of basic psychological literatures concerning the effects of stress on memory and learning would have provided useful foundation for coverage of appraisal, coping, and emotion. Additional sociocultural dimensions of stress of significant interest include religion, spirituality, and acculturation. Within the mental health domain, we confined coverage of the many major forms of psychopathology in which stress appears to play a role to conditions (e.g., depression, trauma) that have attracted considerable interest for their possible physical health effects. In many cases, topics addressed within chapters that we did include easily could have formed the basis for multiple chapters (e.g., on specific individual problem drugs or different cardiovascular disorders). Similarly, the many different techniques that have been developed as means of reducing stress warrant handbook-sized coverage on their own.

## CONCLUSIONS AND OUTLOOK

Nonetheless, within the confines of a large but manageable set of chapters, we believe that this *Handbook* captures

the major contours and essential features of a clearly identifiable and important area of research. That research is concerned with understanding the role of stress in physical health and disease. Each of the individual chapters in this volume stands as a significant contribution in its own right. Taken together, the full set of chapters captures the excitement and promise, as well as the challenges, of a vibrant and productive field of inquiry. Accordingly, we believe this book will serve as a valuable resource for many years to come. Over time, the value of stress science will be judged by the progress that is made in the further accumulation and practical application of knowledge about the nature of stress, its causes, and its consequences for human health. We hope and expect that this *Handbook* will inspire current and future stress scientists to make the discoveries that will bring about such progress.

## ACKNOWLEDGMENTS

I would like to thank David C. Glass for his helpful comments on earlier versions of this chapter.

## REFERENCES

- Berntson, G. G., & Cacioppo, J. T. (2007). Integrative physiology: Homeostasis, allostasis, and the orchestration of systemic physiology. *Handbook of psychophysiology* (3rd ed.) (pp. 433–452). New York: Cambridge University Press.
- Betensky, J. D., Glass, D. C., & Contrada, R. J. (in press). Psychosocial factors in cardiovascular disease: Emotional states, conditions, and attributes. In A. S. Baum, T. A. Revenson, & J. E. Singer (Eds.), *Handbook of health psychology* (2nd ed.). New York: Psychology Press.
- Bollini, A. M., Walker, E. F., Hamann, S., & Kestler, L. (2004). The influence of perceived control and locus of control on the cortisol and subjective responses to stress. *Biological Psychology*, 67(3), 245–260.
- Cacioppo, J. T. (2007). Psychology is a hub science. *Observer*, 20(8), 5 & 42.
- Cannon, W. (1928). The mechanism of emotional disturbance of bodily functions. *The New England Journal of Medicine*, 198, 877–884.
- Cannon, W. (1929). The sympathetic division of the autonomic system in relation to homeostasis. *Archives of Neurology and Psychiatry*, 22, 282–294.
- Cohen, S., Kessler, R. C., & Gordon, L. U. (1997). Strategies for measuring stress in studies of psychiatric and physical disorders. In S. Cohen, R. C. Kessler, & L. U. Gordon (Eds.), *Measuring stress: A guide for health and social scientists* (pp. 3–26). New York: Oxford University Press.
- Coyne, J. C., & Racioppo, M. W. (2000). Never the twain shall meet? Closing the gap between coping research and clinical intervention research. *American Psychologist*, 55(6), 655–664.
- Dohrenwend, B. P., & Shrout, P. E. (1985). "Hassles" in the conceptualization and measurement of life stress variables [Comment/Reply]. *American Psychologist*, 40(7), 780–785.
- Engel, B. T. (1998). An historical and critical review of the articles on blood pressure published in *Psychosomatic Medicine* between 1939 and 1997. *Psychosomatic Medicine*, 60(6), 682–696.
- Glass, D. C. (1977). *Behavior patterns, stress, and coronary disease*. Oxford, England: Lawrence Erlbaum.
- Glass, D. C., & Singer, J. E. (1972). *Urban stress. Experiments on noise and social stressors*. New York: Academic Press.
- Hoffner, C. (1993). Children's strategies for coping with stress: Blunting and monitoring. *Motivation and Emotion*, 17(2), 91–106.