

# ENVIRONMENTAL STRESS

**EDITED BY  
GARY W. EVANS**



# Environmental stress

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# Foreword

Traditionally, the president of the Society for the Psychological Study of Social Issues (SPSSI) contributes a foreword for SPSSI-sponsored books published during his or her presidential year. This honor should have been Clara Mayo's. Her untimely death during her first few months of office has led me, as past president of SPSSI, to write in her stead.

I believe that this book represents the best of both theoretical and applied work on environmental stress. It offers a conceptual integration of research on stress, reviews what is known about specific environmental stressors – noise, crowding, temperature and air pollution – and examines stress in a diverse array of specific environments – hospitals, schools, office buildings, and neighborhoods. The authors' multivariate approach helps to bring about much-needed convergence between laboratory and field studies. The book dovetails applied problem-solving with theoretical concerns. It will play a useful role in helping societies and individuals to understand, and to seek solutions to, the impelling problems of stress and poor environmental design. SPSSI is pleased to sponsor this volume, in the best tradition of research on the psychological aspects of important social issues.

Leonard Bickman  
Vanderbilt University

# Editorial preface

The relationship between human behavior and the physical environment assumes two basic forms. On the one hand, our behavior affects environmental quality: The amount of energy we consume, the products we buy, and the economic and political policies we support affect environmental conditions. On the other hand, the quality of our physical surroundings affects our mental and physical health. In this book we focus on the latter relationship by examining what happens when individuals are exposed to suboptimal environments.

This book has four specific objectives. The first is to provide some conceptual integration across several environmental problem areas by utilizing the concept of stress as a unifying theme. Noise, heat, air pollution, and crowding can all be viewed as nonoptimal environmental conditions that may elicit behaviors designed to modify that suboptimal human-environment relationship.

The second objective is to demonstrate how the stress concept can be used to understand human behavior in designed environments. Most research on human responses to the built environment has been atheoretical, focusing on postoccupancy assessments of user satisfaction. Following a general introduction to the ways in which the stress concept can describe dysfunction between human needs and the designed environment, sources of stress are discussed in four specific settings: medical hospitals, schools, offices, and neighborhoods.

Third, we review existing knowledge about the effects on human behavior of four environmental stressors: noise, heat, air pollution, and crowding. As is apparent in the various chapters in this volume, there is considerable variety in what, and how much, we know about these stressors. Although some environmental conditions such as air pollution have received scant attention from behavioral scientists, other sources of environmental stress such as crowding and noise have received considerable coverage. Empiri-



cal findings about each stressor are organized, in general, around three main areas of impact: health and physiology, performance, and affect and social behavior. Research on designed settings is also reviewed, with an emphasis on physical features that influence user satisfaction. The impact of environmental design on health and performance has received relatively little research attention, however.

Our final objective is to stimulate thinking about the ways in which research on behavioral aspects of environmental problems can be integrated into decision-making processes. A central feature of the National Environmental Policy Act of 1969 was the creation of the environmental impact review process, which mandates the assessment of environmental impacts of any federal action that could significantly affect environmental quality. Since this Act, over one-half of the states have extended the environmental impact review process to their own actions as well. Interestingly, in their report on the environmental impact review process, entitled *Planning for Environmental Indices*, the National Academy of Sciences and the National Academy of Engineering conclude that a major shortcoming of the environmental impact review process is inadequate assessment of environmental change on human health and well-being (Washington, D.C.: Environmental Studies Board, 1975).

Support and guidance for the preparation of this book came from many sources. The book evolved from a volume of the *Journal of Social Issues* on the same topic. The papers from that issue were expanded, and four chapters on specific designed settings were added. I am particularly grateful to James McGrath for his excellent stewardship as Editor of the *Journal of Social Issues*. I appreciate the sponsorship of this book by the Society for the Psychological Study of Social Issues and thank Marilyn Brewer and Jeffrey Rubin for their help. All royalties from this book are donated to the Society.

I thank Joseph DiMento, Director of the Program in Social Ecology, University of California, Irvine, and M. N. Palsane, Head of the Department of Experimental Psychology, University of Poona, Ganeshkind, Pune, India, for providing institutional and personal support during the preparation of this book. Susan Milmoie and the editorial staff at Cambridge University Press have provided considerable expertise that has helped shape and refine this book. I thank Jill Vidas for assistance with the manuscript and Mary Anne Skorpanich for preparation of the indexes. Finally, I am grateful for support from a Fulbright award that enriched my sabbatical year in India, and for grant support from the National Science Foundation (BNS 77-08576), the National Institute of Environmental Health Sciences (1 R01 ES0176401 DBR), Southern California Edison Health Effects Research Division (B-2058902, J-1909902), and the Focused Research Program on Stress, University of California, Irvine.

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# General introduction

*Gary W. Evans*

This book evolved out of a need to more fully understand the ways in which suboptimal environmental conditions affect human health and behavior. The environmentalism and ecological concern of the 1960s helped to generate scholarly interest in the effects of environmental problems on human health. Much of the initial work in this area was done by biological scientists.

In the late 1960s and early 1970s, a few behavioral scientists became interested in these effects. Early research efforts in the new field of human-environment studies focused on two broad topics: design and user satisfaction, and human responses to pollution and overpopulation (Craig, 1973; Kates & Wohlwill, 1966).

In some respects, the emergence of human-environment studies represented a convergence of two relatively distinct intellectual paradigms: (1) environmental sciences, which focus primarily on the conditions of the biosphere, and (2) the study of human behavior, conducted by psychologists and other social scientists. Human-environment studies emphasize the transaction between these two perspectives and focus on two key questions: How does variation in the physical environment affect human behavior?; and How does variation in human behavior affect environmental quality?

This book illustrates how the transactional construct of stress can be used to understand this interaction. Stress is defined broadly as any situation in which the environmental demands on individuals exceed their abilities to respond. There are many definitions of stress and considerable controversy about which are proper definitions. The reader interested in this problem should see Appley and Trumbull (1967), Lazarus (1966), McGrath (1970), and Selye (1956). Definitions vary in their specificity and the extent to which they emphasize physiological or psychological processes.

### **Limitations in biological models of human–environment interaction**

Biological models of the human–environment interface derive from animal models and emphasize interactions between environmental constituents and the physiological response of the organism. Although the biological perspective has undoubtedly made enormous contributions to understanding the human–environment interface, it has important limitations. Some of these led to the emergence of human–environment studies as a focus of inquiry for social scientists.

#### *Direct effects*

One limitation of the biological perspective is the emphasis of biological models on direct, environmental effects on human health. Rene Dubos (1965) was among the first biologists to note the role of cognitive mediators between physical stimuli and human responses. Human beings, to a much greater extent than other animals, interact with the symbolic, cognitively constructed world. The contexts in which stressors occur have important influences on our cognitive appraisals of events. The distinction between noise and sound may serve as an example. Human reactions to sound levels of a given physical intensity (e.g., decibel levels) are mediated by a host of individual and contextual variables. Reactions ranging from cardiovascular changes to annoyance are strongly linked, for example, to individual judgments of the importance of the noise source, or perceptions of personal control over the noise (Cohen & Weinstein, Chap. 2, this volume). One person's music may be another's noise.

#### *Pathogenic outcomes*

A second limitation of the biological perspective on environmental health is the overemphasis of biological models on pathogenic outcomes. Toxicologists, epidemiologists, and other health-related scientists tend to concentrate on serious, catastrophic measures of health. Mortality and morbidity, although of paramount importance, are not the only health indexes worthy of examination. Irritability, depression, anxiety, and other indicators of mental health can be affected by changes in environmental quality. Affect, mood, and interpersonal relationships can also be impacted by physical surroundings. Furthermore, as increasing evidence shows, the susceptibility of the host organism to disease is drastically altered by psychological factors (Monat & Lazarus, 1977). Psychosomatic diseases are no longer a small, specialized area of medicine. Stress has been implicated in a wide array of health problems. Thus, psychological variables play important roles both as final outcome measures and as mediators that can predispose us to react more severely to environmental insults.

### *Methodological limitations*

Both biological and ecological research strategies have been criticized on methodological grounds. Many biological studies of environmental influences on human health use the traditional experimental paradigm with laboratory-based controls and isolation of key causal variables. Although this approach to scientific research has many strengths (cf. Platt, 1964), it comes at a cost of limited generalizability. Do isolated, highly controlled reactions occur in the same way in the "real" world as they do in the lab? Field research, on the other hand, also has limitations. Aggregate-level associations of "real" phenomena often leave the researcher with vague descriptions of causal processes that are subject to reasonable alternative explanations.

As the research reviewed in this volume indicates, it is possible to combine experimental rigor with the realism provided by naturalistic studies conducted in the field. Among the strategies employed in environmental stress research to achieve this meshing of the two approaches are longitudinal studies of individual respondents and cross-validation studies of experimental and naturalistic findings. Nevertheless, researchers of environmental stressors have by no means solved the difficult problems related to experimental and nonexperimental research methodologies. Moreover, although there are several serious methodological problems specific to stress research (discussed later), *some* research on environmental stress does illustrate the possibility of rigorous, externally valid research.

### **Models of stress**

Two dominant models of stress influence the research discussed in this book. These emphasize, respectively, physiological and psychological processes in the reactions of organisms to environmental intrusions and demands. Both models are described in detail in Chapter 1 by Baum, Singer, and Baum. Thus, we provide only a short overview of the two approaches here.

#### *Physiological models*

Physiological responses to stressors were described by Hans Selye (1956) in his efforts to explain various nonspecific reactions of the pituitary-adrenal axis to pathogenic insults. Selye noted that when rats were exposed to a variety of environmental insults, a common pattern of bodily reactions consistently occurred regardless of the particular insult the body encountered. Selye termed this pattern of nonspecific responses the General Adaptation Syndrome, which includes a sequence of alarm, resistance, and exhaustion that is characterized by certain physical events. Briefly, these events include ACTH-mediated adrenocortical activity that causes gluco-

corticosteroid secretion (anti-inflammatory agents) from the adrenal cortex and other areas. This in turn triggers catecholamine output (e.g., adrenaline) from the adrenal medulla. If resistance to the pathogen is successful, adaptation to the stressor occurs and this somatic sequence ceases. If somatic defense becomes depleted, exhaustion occurs, and the body loses its capacity to respond to attack by external pathogens. Work by Mason, Lacey, and others has challenged the nonspecificity hypothesis of Selye's model, but the general pattern of somatic responses is well accepted in the stress literature (Lacey, 1967; Mason, Maher, Hartley, Mougey, Perlow, & Jones, 1976).

Two aspects of Selye's model have strongly influenced work on environmental stress. Many stress researchers accept, in principle, that the body has a finite amount of adaptive energy available to cope with stress. Depletion of this energy reserve is viewed as harmful to the organism as it leads to serious disequilibrium. There is also an implied homeostatic model of bodily function with coping processes viewed as efforts to maintain internal stability (Cannon, 1963). Second, the processes involved in coping are seen as having negative effects independent of the harmful impacts of the stressor (Cohen, Krantz, Stokols, & Evans, in press).

### *Psychological models*

Psychological models of stress emphasize cognitive interpretations of environmental conditions. Work in this tradition has been heavily influenced by Richard Lazarus's research on psychological stress (Lazarus, 1966; Lazarus & Launier, 1978). According to Lazarus, individuals appraise how threatening events are. The extent to which an event will be seen as threatening is dependent upon a constellation of personal and contextual features. Individual attitudes about a stressor, prior experience with it, knowledge of its costs, and evaluations of alternative courses of action can all influence how an event is appraised. Furthermore, the severity and chronicity of the stressor itself can influence this assessment. An appraisal of no threat, for example, is more likely to occur when the individual believes the stressor is marginal, short-lived, or relatively familiar.

Once an event has been appraised as worthy of response, coping processes ensue. Secondary appraisal encompasses an accounting of one's coping resources and generally is manifested by either instrumental or palliative coping. Instrumental coping involves direct action to remove the stressor, efforts to learn more about it, or strategies to filter its impact on the individual. Thus, instrumental coping with noise, for example, might include asking your neighbor to turn the stereo down, calling the airport to complain or to obtain more information about jet overflights, or wearing ear protectors while on the job. Palliative or intrapsychic coping entails reappraisal of the stressor by psychological means such as defense mechanisms. One might cope with air pollution by deciding that your neighbor-

hood, in comparison to adjacent areas, is relatively pollution free. Alternatively you may feel that bad air quality has little effect on your own health because you have not experienced any respiratory problems where you live. Finally, poor visibility may be attributed to fog or other "natural" causes rather than to smog or air pollution.

### **Limitations of the stress construct**

Several limitations of the stress construct are also of concern to environmental researchers and are discussed by the chapter authors. One of the major conceptual difficulties is the lack of convergence between psychological and physiological perspectives on stress. Little theoretical or empirical work has addressed this difficulty, but some progress has been made recently on two aspects of this problem.

First, Mason and his colleagues recently argued that psychological threat is a necessary prerequisite for activation of the pituitary–adrenal, somatic responses characteristic of the General Adaptation Syndrome (Mason, 1975). Selye disputes this position, and the issue currently stands at a point of controversy (Selye, 1975). Second, some research indicates that stressors have some direct physiological effects (e.g., elevated heart rate) that are distinct from physiological effects due to coping efforts (e.g., increased catecholamine output) (Frankenhaeuser & Lundberg, 1977; Lundberg & Frankenhaeuser, 1978).

The largely distinct influence of the psychological and physiological perspectives on stress has led to two additional problems. One is the relative importance of objective and subjective stressors for human health and behavior. It is unclear which are more crucial in determining human reactions: the actual physical parameters of stressors, or subjective appraisals of stressors. It is also possible that the issue is more complex. Perhaps some physiological outcomes are more sensitive to objective characteristics of the stressor, whereas other behaviors are more reactive to subjective appraisals of threat or harm. Although there is much discussion about the importance of distinguishing between, for example, sound and noise or density and crowding, remarkably little research has focused directly on how well objective versus subjective stressors predict human behavior.

The second problem stemming from the dual influences of the physiological and psychological perspectives on stress concerns the coping process. Many of the immediate effects of stressors on human beings may go undetected because of the adaptive resources available to the individual for coping. Many early studies of environmental stressors and task performance, for example, concluded that stressors such as noise and crowding had no negative effects on human task performance. As we now know, these conclusions were premature because stressor effects on task performance are very subtle and are masked to a large degree by individual efforts to maintain normal performance levels. Current views of stress and



human performance suggest that stressors can degrade performance on certain kinds of complex tasks or cause negative aftereffects in performance. Tasks with multiple signals, rapid signal presentation, or low probability signals are disrupted by environmental stressors such as noise (Hockey, 1979) and crowding (Evans, 1978). After periods of exposure to these stressors, performance on tasks suffers when the stressor is no longer present (Cohen, 1980). Individuals can perform at normal levels on many cognitive tasks during stress. With the use of measures that have sufficient task complexity, or that measure aftereffects, the costs of coping efforts can be detected.

Another conceptual limitation of the stress construct is confusion about what physiological indexes of stress and coping should be used in research. One aspect of this limitation centers on the definition of stress as a nonspecific set of physiological adaptations, described earlier (Selye's General Adaptation Syndrome). There is disagreement over which physiological indexes to monitor, and whether they should be highly correlated or form stressor-specific patterns. This controversy is further complicated by the fact that when attention is paid to external stimuli, a different physiological pattern (directional fractionation) occurs than when efforts are made to inhibit external sensory input (Kahneman, 1973; Lacey, 1967). Thus, when measuring the effects of stressors on task performance, the researcher must take into account that the individual's attention to task cues has some physiological consequences. Furthermore, efforts involved in coping with stressors have their own effects on physiological states, which are distinct from the effects of the stressor. All of these additional variables, plus parameters of the stressor itself, can affect human physiological responses. Understandably, there is now a good deal of confusion about how to interpret physiological measures in stress studies.

Large individual differences are often noted in response to stressors. A statistical implication of this fact is that many tests for stress effects have low statistical power because of large, unexplained within-groups variance. The existence of individual differences also relates to the objective-subjective issue already raised. Many studies of environmental stressors may have large intragroup variances because of varying personal appraisals of stressors. Some of the more promising individual difference variables noted to date are the extent of previous experience with the stressor, the individual's age, and the expectancy or set of the individual, particularly with regard to control over the stressor and the environment in general. Efforts to identify a general stress-prone personality variable have proven unsuccessful so far.

Finally, the knotty problem of how stressors interrelate is still largely unresolved. Curiously, although many early volumes on stress noted the importance of this issue (Appley & Trumbull, 1967; Lazarus, 1966; McGrath, 1970), little research on this topic has ensued. The problem is interesting for several reasons. Conceptually the issue relates to the integrity of the stress construct itself. If various kinds of changes in physical conditions