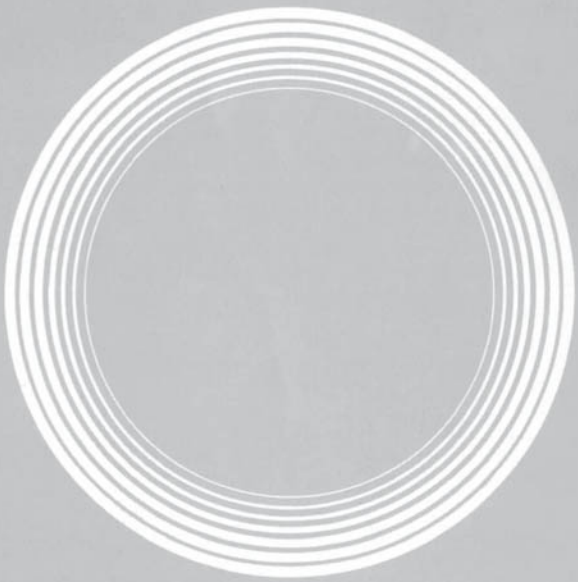
The Biopsychology of Mood and Arousal



Robert E. Thayer

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To Elsie, Daniel, Leah, and Kara,
four loved ones in two generations who have given me much.

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PREFACE

This book presents a broad analysis of nonpathological mood states and reviews the scientific research on mood that has taken place over the past decade. Although most of this research has a psychological basis, I have attempted to demonstrate that the central concepts have clear biological underpinnings, and that the best current understanding of mood occurs in this context.

The complex model for conceptualizing mood outlined in these pages is the product of over two decades of empirical research that has led me to a theory of naturally occurring arousal states and their manifestations in conscious awareness. My research began with detailed psychometric analyses of core mood states and a variety of construct-validation studies incorporating psychophysiological assessments and predictions taken from general biopsychological theory. I have been encouraged by colleagues to draw much of this work together and to relate it to current research on mood, because many of my more important early findings have since been validated and extended by others working in laboratories on diverse scientific problems.

The kind of biopsychological analysis of mood offered here is currently quite popular, but this was not always the case. American psychology has moved from behaviorist models in the 1960s that almost entirely neglected mood as important to influential cognitive paradigms in the 1970s that neglected affect and mood variables as well. Only now have scientists from many orientations begun to recognize that moods are natural biological processes. It is increasingly clear from expanding research programs, or at least from theoretical comment, that behavioral and biological scientists regularly think of moods and emotions as significantly affected by basic biological influences such as sleep-wake rhythms and other biological cycles, by psychomotor activity, and nutritional substances, and in the larger sense by biologically fixed temperaments that set limits to the mood changes an individual can experience. There is also increasing recognition that affective states themselves significantly influence a variety of cognitive and motivational processes.

Writing this book has offered some special degrees of difficulty. In addition to researchers concerned with mood-related topics, the book is intended for scientists and professionals from diverse backgrounds. For example, I have attempted to make the work accessible to exercise physiologists, nutrition scientists, psychotherapists, and biologists concerned with human behavior. This represents a wide variety of disciplines, and although each field employs scientific methods, each has its own technical language, and to some extent its own

empirical approach. Consequently, in writing the book I often found myself dealing with a technical concept by focusing on the underlying logic and, not infrequently, the reader will encounter explanatory passages where I have avoided the use of a technical term that would have made the discussion considerably more difficult for some readers.

As a second point about intended audience, I should indicate that my work has never been concerned primarily with self-help applications. The concepts under discussion, however, are so immediate to most people's experience that questions of application inevitably arise. In my experience it is clear that individual differences are very important and, therefore, the first step in applying these ideas is usually systematic self-observation. Over the years of teaching upper-division university classes on research methodology, I have developed procedures for longitudinal self-studies of mood that are both didactically valuable, and that students find quite personally beneficial. Thus, I have included several detailed appendixes with measurement materials and procedures (both technical and simplified) so readers can carry out sound self-observational studies.

My work on mood owes much to the pioneering ideas of early biopsychologists such as Donald Hebb, Elizabeth Duffy, and Robert Malmo. These broad thinkers recognized that superseding the great complexities of the body there are general variations that provide understanding that is lost if the intricacies become too much the focus. Furthermore, their recognition of the close association of physiological and psychological processes appears to be accepted without question today, but their work did much to set the stage for that understanding. My work also owes much to Vincent Nowlis, my professor of many years ago who oversaw my doctoral dissertation and who pioneered most of the multivariate methods for the study of mood that are in wide use today.

A large number of individuals have been of great immediate help in the writing of this book. They gave their time and efforts to carefully read and critique various chapters, and in several cases the whole book. I am very thankful for their efforts, and their criticisms were extraordinarily valuable, but these colleagues cannot be blamed for any shortcomings of this book since in many cases I chose not to follow all their suggestions.

Martin Fiebert, Kirby Gilliland, and Auke Tellegen read the whole book and provided systematic comments on each chapter. Martin Fiebert was particularly helpful because his prompt and insightful feedback about each chapter was provided as the book was being written. Colleagues who read large portions or individual chapters of the book and who provided valuable feedback include Alexander Beckman, Hans Eysenck, Kenneth Green, Raphael Hanson, Ralph Hupka, Jeanne Kohl, Kevin MacDonald, Ruth Stewart, Nancy Voils, and Sharon Wolf. I am also thankful for the help of various editors at Oxford University Press, and particularly for the invaluable assistance of Joan Bossert and Linda Grossman.

July 1988 R.E.T.
Long Beach, California

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THE BIOPSYCHOLOGY OF MOOD AND AROUSAL

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Introduction

For laypeople, moods are background feelings that last for a time and that often have no particular cause. Usually a mood is identified simply as "good" or "bad." Sometimes moods are invoked as explanations for someone else's unusual behavior. They may account for the fact that the individual is acting differently than expected in a given situation. Moods are so much a part of everyday life that much of the time little thought is given to them, and yet most people consider them to be important. From time to time, powerful moods appear to be more significant in controlling one's life than events. At these times it seems that they not only influence feelings but most thoughts as well.

The scientific study of mood has a respectable, although not extensive, history. Philosophical analyses have shown that moods predispose other behaviors (Nowlis, 1965; Ryle, 1949). Medical analyses have identified some of the biochemical bases of disordered states of mood (Green & Nutt, 1983; Post & Ballenger, 1984; McNeal & Cimbolic, 1986). Measurement studies have shown that moods can be reliably assessed (Purcell, 1982; Watson & Tellegen, 1985; Thayer, 1967). And psychological analyses have given a picture of wide-ranging antecedents and consequences of a variety of mood states (see Chapter 2).

Mood studies were not always welcomed by the scientific community, however. For example, the behavioral and cognitive paradigms so prevalent in the 1960s and 1970s often tended to devalue the significance of moods. Frequently, mood and affect went without mention in prominent analyses of behavior (Zajonc, 1980). As will be clear in the pages that follow, however, this devaluation is changing in recent times. Most behavioral analyses today include significant affective components (cf. Tomkins, 1981).

An individual's moods are sometimes characterized by extremes, or pathological deviations. But most of the time, people fall within a middle range of feelings that occur periodically during daily life patterns. These middle range feelings, which are the main focus of this book, have important biological significance, and represent essential information about personal transactions with the world. As I shall attempt to demonstrate in Chapter 3 and elsewhere, certain core mood states give vital signals about one's readiness for action and need for rest and recuperation. Feelings of energy and tiredness are the subjective signal

systems of these crucial conditions of life. Other important core moods carry information about danger and safety. Here, the subjective states, or signal systems, range from fear, tension, and anxiety to feelings of calmness and quietness.

The Resurgence of Interest in Mood and Affect

Although mood always was of vital interest to laypeople, and although there has been a substantial scientific research effort to uncover therapeutic methods for dealing with pathological mood states, experimental psychologists have paid relatively little attention to mood until the last decade or so. In the past ten years, however, close to 1,000 scientific papers were published that dealt directly or indirectly with mood and affect. They ranged from careful studies of measurement to analyses of a wide variety of mood antecedents, as well as studies of mood consequences or manifestations.

The physiological and other biological bases of mood are highlighted in much of this research, although the exact mechanisms of operation have not been clarified (Mason, 1984; McNeal & Cimbolic, 1986). What has emerged, however, is the necessity for coordinated physiological and psychological studies to understand these relationships. In addition, the association of mood with all manner of bodily functioning has been amply documented. From the research literature it is apparent that mood is related to illness (e.g., Stone et al., 1987), sleep (e.g., Johnson, 1982; Kleitman, 1963; Taub, 1977), physical activity (Folkins & Sime, 1981), and nutrition (Spring, Chiodo & Bowen, 1987; Thayer, 1987a). There is also excellent evidence that mood and cognition are interrelated in many respects (Isen, 1984), and that mood and memory are integrally associated with each other (Blaney, 1986). Mood as a general bodily phenomenon and the importance of cognitive-affective interaction are central themes of this book.

Although not all the published research on mood and affect has supported the theoretical position presented here, I have tried to review relevant research and theory that both supports and does not support my position. With certain exceptions, the current status of scientific work on mood and affect across the field is surveyed. However, various areas are not fully represented in proportion to the available published material. In particular, the vast literature on pathological mood states, including theories of depression, is not fully reviewed. Instead, the focus is on normal (nonpathological) mood states, especially on the antecedents and measurement questions associated with them. Nor have I attempted to deal in detail with the large amount of technical work on the subjective effects of various drugs, or with the social-psychological work on mood and social behavior.

Mood as a Biopsychological Concept

Mood is primarily a psychological manifestation. Most that is known about it comes directly or indirectly from self-report. Thus, controlled introspections of

affect, together with cognitive processes and external life events, provide the most reliable immediate understanding of this general affective condition. However, even though subjective feelings and psychological processes supply the most basic evidence in any scientific or personal analysis of mood, it is also clear that mood has integrally related psychophysiological and biochemical components. Moreover, elemental biological processes are important influences on mood. Clearly mood is a biopsychological process that involves the whole individual. In other words, moods would not occur without biochemical, psychophysiological, and cognitive components, as well as subjective reactions.

The importance of these nonsubjective components must not be overemphasized, however. It is not uncommon to encounter the implicit assumption that mood is nothing more than a response caused by cognitive, physiological, and/or biochemical events. In other words, subjective feelings are somehow regarded as the last processes in a chain of more important physiological changes. In my view, however, subjective feelings, thoughts, and psychophysiological and biochemical processes all interact together, and each has its own necessary function in ongoing behavior. Therefore, one process is no more influential than the others, and all are necessary for moods to occur.

Since a mood occurs over time, it may be reasonable to consider initiating events (e.g., biochemical changes produced by cognitive interpretations), but once the mood is occurring the interaction of many bodily systems contributes to its full nature. Thus, if a person is experiencing a powerful mood, the biochemical processes that occurred early in the affective reaction will not provide a complete understanding of the continuing mood. For such an understanding it is necessary to view the ongoing interactions among the full range of bodily systems. Furthermore, these reactions do not occur independently of ongoing life events. Understanding the mood must entail reviewing these life events together with all of the multilevel bodily processes.

This also applies to dysphoric mood states. It may be true that a set of events was interpreted as dangerous, which somehow led to complex biochemical changes, and finally to a negative mood state. But even though a cognitive interpretation may have initiated the sequence, the negative mood is an ongoing process that has gone far past the initial interpretations. The initial cognitive reaction becomes much less important as the mood is occurring. Nor does modifying the cognitive reactions ensure mood control. The issue of control is very complicated, and even the most complete studies still do not provide a good understanding of it. It seems likely that cognitive shifts sometimes effectively modify mood states, but other bodily changes may prove more effective. Probably it is a combination of processes that eventually will be found to be most effective in controlling moods.

Considering mood as a biopsychological response has other implications as well. For example, if moods are part of a general biological system, one of the primary implications is that this system has emerged through evolutionary development. In the millions of years in which *Homo sapiens* evolved, probably no major element of the body developed without having a survival function. Therefore, the presence of mood states today indicates that our ancestors were

somehow selected for the capability to have these bodily experiences. At some point in the evolutionary process, moods must have had a genuine functional utility, even though that may not be clear, or perhaps even germane, at the present time. But one can be fairly certain that this usefulness existed, or the biological system would not now be present. Thus, an understanding of moods will be greatly enhanced if this functional significance can be seen more clearly.

Energetic and Tense Arousal

Perhaps the central theme in this book concerns the interactions of two broadly inclusive mood systems. They are called *systems* because it is likely that each includes the simultaneous interactions of a number of mechanisms of bodily arousal. These systems are *broadly inclusive* because they probably extend from the biochemical and cellular levels of function to activation of various subsystems of the brain, and finally to conscious awareness. It is at this highest level of integration—the awareness of bodily sensations and of related subjective feelings—that the most evidence exists for these two systems (Thayer, 1967, 1970). At the psychophysiological and biochemical levels of analysis, the evidence for the existence of these systems is still mixed, perhaps because of the complexities involved. Because the evidence is much more clear at the level of conscious awareness, the most attention will be focused on it.

As shall be discussed further in Chapter 3 (also see Thayer, 1967, 1978a, 1986), the first system—energetic arousal—is recognizable by subjective sensations of energy, vigor, or peppiness. The second system—tense arousal—is associated with feelings of tension, anxiety, or fearfulness. These labels are somewhat imprecise, because their meaning depends on a person's social and linguistic background. That is, two self-observers of different cultures or with different language training would undoubtedly give different names to the same feelings. In fact, there is a sufficient diversity of background even among educated, middle-class American adults to make their self-ratings using these adjectives only crude indexes of the two arousal states.

Although subjective feelings of energy and tension may be measured in a variety of ways, in my research I have usually employed the Activation-Deactivation Adjective Check List (AD ACL) for this purpose (Thayer, 1967, 1978a, 1986). This is a short test that I developed some years ago to serve as a very general indication of momentary levels of different arousal states (see Chapter 3 and Appendix I). The AD ACL is one of the more widely used self-rating tests for assessing mood, but it is particularly popular when psychophysiologically related arousal states are of interest (Mackay, 1980).

Energetic arousal and tense arousal, as I call the two major mood systems, represent two very basic mood-behavior orientations. In the first case, feelings of energy predispose a person to move, to act, to be physically active. Declines in these feelings, together with feelings of tiredness, generally impel rest or inaction. On the other hand, in relation to the second system, when some real or imagined danger is present, feelings of tension, anxiety, or fearfulness also pre-

dispose preparation for action. With activation of the tense arousal system, however, there is not only preparation for action, but also restraint or inhibition. The idea that these inhibitory responses act together with actions that prepare for bodily readiness seems inconsistent with certain elements of the long-standing biological theory of the "fight or flight" syndrome. But, as I shall argue in Chapter 5, a careful analysis of original work on this theory indicates that this inhibitory process, coupled with preparation for action, is quite consistent with that long-standing concept (Arnold, 1945; Cannon, 1929/1963).

In a sense, these two mood systems are represented in consciousness as two kinds of subjective energy. One of them is called "tense-energy" and the other "calm-energy." It is often difficult to explain the difference, as many people associate tension with energy. This is understandable in a society inundated and inured by stressors, where many people are tense most of the time. Thus, when low-level chronic tension becomes the norm, the tension feelings may go unnoticed.

The feeling of calm-energy is often recognized by persons who have regularly practiced relaxation or have mastered stress-management techniques. People with extensive athletic training often understand this state as well. These groups may possibly be more attuned to the differences because they have sufficiently often experienced a rapid change from tense-energy to calm-energy, and thus the two states are distinguishable to them.

Energetic and tense arousal are at the core of many other commonly identified moods (see Chapter 8). For example, low energy and high tension are basic components of depression, particularly agitated depression (Amer. Psychiatric Assoc., 1980). Optimism is closely associated with high energy and low tension, as are happiness and pleasurable bodily feelings (Thayer, 1987b). Finally, calm-energy is a pleasurable feeling that might be identified simply as a good mood, while tense-tiredness is unpleasant and might be identified as a bad mood.

As will become apparent in Chapter 6, one of the most far-reaching implications arising from the separation of the energetic and tense arousal systems is that there is a predictable relationship between feelings of energy and tension at different levels of intensity. For example, it appears that a moderate amount of tension raises energy feelings, as when an upcoming deadline is remembered and an individual is motivated to get to work. However, as many people realize, *reduced* energy is the result of substantial amounts of tension, or long-standing debilitating tension. On the other hand, *increasing* energy often has a tension-reducing effect.

This complex relationship between energy and tension feelings is important theoretically because it makes understandable certain otherwise confusing everyday life occurrences. Some of the immediate implications considered most extensively in this book relate to the rhythmic increase or decrease of tension within a circadian energy cycle. For example, tension is often greatest at the times of day, such as late afternoon, when energy is low. But tension is reduced when energetic arousal is increasing or at the times of day, such as late morning, when energy is high.

Tension reduction is also considered extensively in relation to the energy variations that occur with gross voluntary motor activity. This can explain the familiar positive effects of physical activity, particularly moderate exercise. It is increasingly evident that many sorts of moods are modulated to a substantial degree by complex interactions of energy and tension as these states are affected by exercise.

There are a number of other examples of apparently anomalous relations among arousal states that at least bear examination in the context of this assumed complex relationship between energy and tension. For example, consider the differential effects on energy and tension of various psychoactive drugs such as caffeine, cocaine, and tranquilizers (see Chapters 6 and 8). When caffeine works optimally, it increases energy and alertness while decreasing tension (Sawyer, Julia, & Turin, 1982). The street use of cocaine often produces the same affect for its users (Grinspoon & Bakalar, 1985). Tranquilizers, on the other hand, work optimally when they decrease anxiety or tension and leave energy unaffected or increased (Iversen & Iversen, 1975). In each case, these apparently anomalous effects might be understood within the complex relationship described between energetic and tense arousal.

It is possible that the motives behind sugar-snacking are also based in this complex relationship (Thayer, 1987a; also see Chapters 5 and 8). The amount of research on food and mood is surprisingly small, but there is some evidence that one important reason for snacking on simple carbohydrate foods may be to raise energy, a motive quite unnoticed by most. Instead, if self-analyses are made, the snack is seen as somehow causing a person to feel better, and in particular, less tense. There is evidence, however, that the short-term energy boost derived from the food not only provides positive feelings, but may also be instrumental in whatever tension reduction occurs. In these ways as well as a variety of others, the complex relationship between energy and tension could be the basis of significant daily behavior patterns.

Mood, Perception of Personal Problems, and Self

Basic perceptual processes regarding self and the world are probably affected by mood (Bower, 1981; Isen, 1984). As an example, consider long-term personal problems, the kind that most people have to a greater or lesser degree. A commonsense view of mood as related to personal difficulties and troubles is that circumstances in a person's life are positive and negative in nature, and that at any particular time the individual's moods are good and bad because of the problems (McArthur, 1972). A strict cognitive-behavioral analysis of this view would stress interpretations of external events as affecting mood. They are certainly important, but they are not the only important aspect in the perception of personal problems.

As will be argued in Chapters 4 and 5, a very interesting and largely overlooked element is that naturally occurring moods, particularly energy and tension, may subtly color the reality of the personal problems (Thayer, 1987b). In other words, *interpretations* of personal problems at any one time appear to be

only partially influenced by what is actually happening in the external environment. Also important is how energetic or tired one is at the moment, together with the degree of tension or calmness. While these differences are not large, over time they can be important.

This is quite a fundamental idea, particularly in light of the transitory nature of energy feelings. A normal person's general energy state shifts each day in a predictable cycle that appears to be largely endogenously controlled (Thayer, 1967, 1978b; Thayer, Takahashi, & Pauli, 1988). Therefore, the same personal problems appear different at ten o'clock in the morning—the high-energy time—than they do at four in the afternoon or eleven at night—the low-energy times (Thayer, 1987b). Evidence will be presented in Chapter 4 that these subtle but measurable differences in problem perception are due to an internally shifting biological cycle of energy and the interaction of this cycle with tension.

The fundamental nature of this view of personal problems is further emphasized when one considers that even moderate exercise significantly raises energy feelings (Thayer, 1978b, 1987a, 1987b), and therefore the perceptions of problems may also change in this process. Similarly, within minutes of ingestion, common substances like sugar and caffeine affect energy (Sawyer et al., 1982; Thayer 1987a). Here the evidence is not definitive, but it is quite possible that these substances also subtly affect problem perception. Thus, as one's energy state is continuously changing, important elements of perceptual reality may also be changing.

The immediate theoretical extensions of these ideas regarding moods, personal problems, and even optimism are quite important, and the implications arising from this viewpoint are wide-ranging indeed. For example, one can consider mood-cognition relationships as similar to the memory associations that occur with drug conditions. In this state-dependency paradigm, learned responses seem to be closely associated with artificially induced states. Thus, each time those states are reintroduced, the same learned responses are consciously produced (Blaney, 1986; Bower, 1981). This may have something to do with the way information is stored within the brain or it may be simply a result of the context of the situation.

There may be a similar kind of cognitive-affective state association related to naturally occurring moods (Thayer, 1987b). For example, when an individual feels highly energetic, and at the same time is relatively calm, his or her perceptions of both self and the world are distinctly different from when that person is tired and at the same time tense. Not only are memories of past successes and failures likely to be different, but perceived likelihoods of future successes and failures are also probably different. In one case self-esteem is high, and in the other, it is low (Rubadeau, 1976; Rubadeau & Thayer, 1976).

Consciousness and Self-Observation

Another important theme in this book concerns consciousness and systematic self-observation. Much of behavioral science for most of this century has been

distinctly unfriendly to the concept of consciousness, which never quite fit into the hard science that was sought (Boring, 1953; Lyons, 1986; Natsoulas, 1970). Consciousness can't be directly observed, even with the most sophisticated physiological instruments, but must be described by a fallible observer. Many seem to feel implicitly that an adequate science cannot exist on such a soft substrate.

This book presents the view that the psychology of mood not only must take account of consciousness, but at this point in scientific understanding of the person, this psychology must be largely based on systematic self-observation of states of consciousness. There is little doubt that moods have biochemical elements or that physiological processes are important parts of mood states. But even with the current understanding of these complex processes, the vital dependent variable is still how a person feels.

With all that, a reasonable question still remains: Can systematic self-observation of states of consciousness really provide a science of mood? Is it not hopeless to expect that at a psychological level one can understand the complex biosystem of a person, with its intricate neural interconnections and wide-ranging biochemical processes? In my view, the answer to these questions is that it is not a matter of using one level of analysis *or* another. Moods are probably biochemically mediated, and the brain is probably the locus of their control. What is called consciousness is probably the highest of many interacting systems (Thayer, 1967, 1970, 1986). It is a manifestation of integrated processes that are occurring at a number of levels simultaneously.

From the point of view of the investigator, consciousness can provide a more wide-ranging, and in one sense, more easily interpretable, picture of mood than lower-level physiological processes. An analysis of mood, going from the more basic biochemical level up through molar physiological levels and to the level of conscious awareness, is somewhat analogous to looking at an object through a microscope while changing powers. At the highest power of resolution, elements of the object can be seen that are lost at other levels, but conversely, more general patterns can only be viewed at lower levels of resolution (cf. Peele, 1983). In the case of mood, the more easily interpretable mood-behavior relationships can be viewed only at the level of conscious awareness. These general patterns are easily lost as one moves toward precise biochemical analyses. Valuable and unique insights into mood can be gained at each level, however.

The importance of consciously experienced mood states is even greater when one considers their probable biological function. As indicated earlier, these subjective states are not likely to be accidents of biology. Instead, they serve as signal systems about general bodily conditions. Because they exist at the highest level in the hierarchy from cellular to cerebrocortical processes, moods represent a summation about what is happening in the body at any moment. In ways that are not as yet fully understood, elemental moods probably provide information that the individual can use to modify immediate behavior, make plans for the future, and communicate to others in social settings (Burghardt, 1985; Hilgard, 1977; Schwartz & Clore, 1983; Underwood, 1982).

Mood, Self-Management, and Self-Help

Various other themes, somewhat less developed, are also expounded in this book. For example, the methods by which people manage their own moods of energy and tension in everyday life circumstances are considered. Most adults have devised methods for handling energy supply and anxiety control, but many of these strategies have not received a great deal of attention by researchers. It is clear, however, that in individual cases the strategies are often ill-considered and the results frequently quite unfortunate.

One sees, for example, a high school student who is going to take a very important SAT exam, but who has had very little sleep for the past few nights. Or one finds people arguing or making decisions about important life issues when they are extremely tired or are under stress. Exercise is often avoided at the very times when it might be most beneficial. In addition, negative long-term effects often develop from some of the most common methods people use to manage energy and tension: using drugs such as caffeine, nicotine, or alcohol. Illicit drugs are also used, but less commonly. And it may be true that the most common "drug" of all used for managing energy and tension is food, particularly sugar (see Chapter 8).

Still another theme in these pages concerns the applications of theoretical and empirical findings to everyday life. Although this is not a self-help book, and no lists of methods to elevate mood are readily provided, this point must be addressed because the topics raised have immediate implications for self-functioning. Years of research and teaching in this area have made it clear to me that an understanding of the dynamics of mood states is an essential first step in alleviating the unpleasantness of negative moods. And the first step in this understanding is systematic self-observation.

If a person realizes that his or her mood is low, while a few hours earlier it was high and there was little change in external circumstances to cause the shift, it is easy to be seduced by the idea that random biochemical factors produced the change. But it may be much more fruitful to look at matters such as one's diurnal energy cycle, amount of previous energy expenditure, amount and type of previous night's sleep, and food recently eaten. Unfortunately, this analysis isn't easy. It is first necessary to have conducted self-observations, probably over sufficient time to assure their reliability. Mood-affecting factors are often very subtle and usually are separated by time from the first appearance of the problem.

This kind of self-analysis is also necessitated by the wide differences among people. For example, it is possible to describe the endogenous energy curve as low upon awakening, rising to a peak at late morning and a subpeak in early evening, and as having low points in late afternoon and just before sleep (Thayer, 1978b; Thayer et al., 1988). But even though this curve reflects most people's energy cycle, it does not capture the important individual differences represented among various cycles—for example, morning and evening types. Similarly, one can cite data which clearly indicate that for most people a mere

ten-minute walk measurably raises energy for one to two hours, but these observations probably would not apply to an aerobics instructor in superb physical condition, and the observations may not apply equally at all times of the day.

What this means for purposes of practical application is that each person must be his or her own expert, and systematic self-observation is an essential tool in that process. To this end, the appendixes of this book provide the measuring instruments and guidelines for a number of self-experiments. None of these is easy, but each offers invaluable information about subtle mood influences and about one's own idiosyncratic reactions to different conditions and circumstances.

In the following chapters, the above ideas will be discussed much more fully. Chapter 2 provides a broad general review of research on mood, particularly that published in the past ten years. Chapter 3 discusses the two central mood systems of energetic and tense arousal much more completely, including their measurement and some of their most important biological and physiological associations. Chapters 4 and 5 deal with important antecedents of energetic and tense arousal, such as biological cycles, exercise, and cognitive-mood interactions. Chapter 6 provides a thorough description of the interactions that occur between energetic and tense arousal, including the conditions under which energy and tension are positively correlated and under which a negative correlation exists.

Chapter 7 systematically analyzes strategies for self-observation, including issues of validity, research design, and the value of self-analyses. The last chapter, 8, is both integrative and somewhat speculative. It discusses common mood states and their relationship with energetic and tense arousal, and also covers the methods that people use to manage energy and tension. In particular, a theoretical analysis is provided of sugar ingestion and of common and illicit drug use. Finally, applications in everyday life of these ideas are extensively considered. The appendixes provide measurement materials and procedures for systematic self-studies.