Chapter 8

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Emotion *and* Stress

As we saw in Chapter 7, motivation and emotion are closely connected. Emotions can motivate behavior both by preceding it, as when a child's anger leads to kicking a bedroom wall, or by being a consequence of our actions, as when behaviors induce feelings of happiness, joy, excitement, and pride.

Emotions do more than motivate our behavior, however. Can you imagine life without them? In this chapter we explore emotions in an effort to find out more about what they are, how they come about, what brain structures enable them, and how they influence our lives. We also explore a closely related topic, stress—the effect of stress on our lives, and the ways in which we can moderate some of the negative effects of stress.

8.1 The Components of Emotion

Although the terms **emotions** and *feelings* are often used interchangeably, feelings are only one component of an emotional response. In fact, lower animals clearly have emotional states, but little or no feeling at all. Perhaps you have seen the color changes of the panther chameleon as it expresses changes in emotion. Humans clearly have both, emotional responses and feelings, which are our sensory experience of the emotional state. In other words, emotions are specific changes in physiological responses, and our feelings are our sensory experiences of these changes. For example, when you experience fear, your body responds with an increase in epinephrine, which causes accelerated heart rate and respiration. We sense these changes and actually feel the emotion. Human emotions, therefore, include four integral components: physiological arousal, cognitive processes, behavioral responses, and affect or subjective feelings.


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The panther chameleon changes color as its emotional states change.

8.1a Physiological Arousal

The first component of an emotion is *physiological arousal*. When someone describes their anger by saying, "the juices were flowing," this account is close to the mark. The "juices," in the form of epinephrine and other hormones associated with the arousal of anger, probably were flowing. As a result of this increased endocrine activity, we might guess that for a few moments at least heart rate increased dramatically, blood pressure probably increased significantly, and breathing may have become rapid and uneven.

Emotions Changes in physiological and behavioral states caused by a stimulus or stimulus context (In humans many of our emotions are experienced as feelings or moods.)

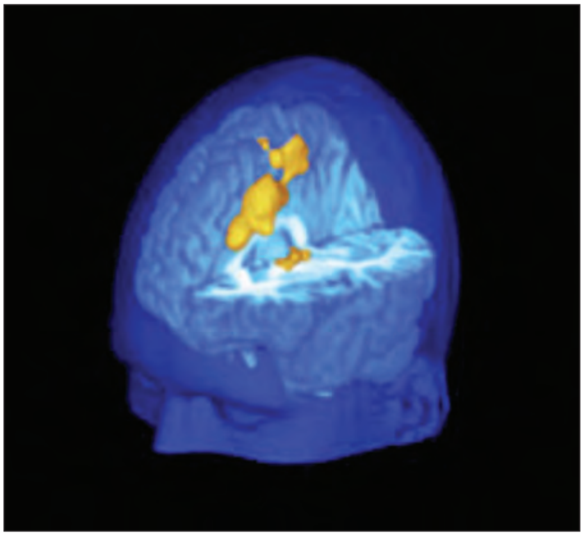
Indeed, emotions are associated with mild to extreme changes in the physiological processes occurring within our bodies. In addition to the changes we just listed, these processes may include metabolic changes, altered muscle tension, changes in activity of the salivary and sweat glands, modified digestive processes, and changes in the levels of certain neurotransmitters in the brain. (Recall from Chapter 2 that the autonomic nervous system is involved in most of the physiological changes associated with emotional arousal.) In other species these physiological processes can lead to changes in coloration, facial expression, piloerection, and other signals of emotion.

8.1b Cognitive Processes

A second component of emotion is cognitive process. Although psychologists differ in the extent to which they emphasize the role of cognition in emotional arousal and expression, there is a general consensus that perception, learning, and memory are all very much involved in experiencing emotions. Listening to music, or even just thinking about a favorite song, often elicits conditioned or learned emotions. In addition, we can easily generate physiological arousal associated with many different emotions by merely thinking about them. Professional actors are particularly good at this. For humans at least, cognitive processes are clearly involved in most emotional responses.

8.1c Behavioral Responses

Emotions also include behavioral responses. They often motivate us to act out or express our feelings. These expressions may range from freezing, crying, screaming in fear, to smiling or laughing. Tone of voice, posture, and other kinds of body language are all common signals of emotion. In addition to expressing and communicating our emotion to others, behavioral reactions of emotions may also serve to either promote or reduce the emotion. For example, avoiding a situation that produces fear or going out of your way to meet a special person are examples of behavior maintained by a change in emotion (recall the two-factor theory in Chapter 5).



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The feeling associated with physical pain is represented in the same brain structures as our feeling of emotional pain. The yellow region is the cingulate cortex.

8.1d Feelings

All human emotions also include an affective component as discussed at the outset. Changes in physiology as well as behavior are detected by our senses and come to represent the feeling of an emotion. Feelings may be described as a general positive or negative state such as joy, anger, fear, or disgust; but many feelings of emotion don't easily fit these descriptions, as we all know well. When psychologists attempt to ascertain a person's emotional state, they typically ask the individual to describe the emotions he or she is experiencing. Most people respond by describing their feelings, as "I am depressed," "I am extremely happy," or "I feel hurt."

Does one actually feel hurt or in pain during an emotion? We are all familiar with the pain associated with the loss of a significant other or the breaking up of a serious relationship, and many songs have been written about that pain. However, do we actually feel emotional pain in a way that is similar to physical bodily pain? According to modern brain imaging research, we do. The pain and suffering you experience with social loss is represented in the same brain regions as bodily pain (Panksepp, 2003). For most individuals, these subjective feelings come to constitute emotion even though they are only one aspect of them.

8.2 The Range of Human Emotion

Adoration, amazement, amusement, anger, anxiety, contempt, disgust, distress, ecstasy, embarrassment, envy, fear, guilt, humiliation, interest, jealousy, joy, loathing, rage, reverence, sadness, shame, sorrow, surprise, terror—these are just a few of the emotions we recognize.

Some of these emotions overlap. Ecstasy and joy, for instance, clearly share certain elements. Thus, differences between emotions are often more a matter of degree than of kind. Furthermore, many emotional experiences may represent a blending of more basic emotions.

8.2a Plutchik's Emotional Wheel

According to Plutchik (1980; 2005), there are eight primary or basic human emotions, which consist of four pairs of opposites: Acceptance and disgust, fear and anger, surprise and anticipation, and sadness and joy. Plutchik adopted the unique approach of arranging these eight primary emotions on an emotion wheel (see Figure 8-1). He maintains that all human emotions are variations or derivations of these eight. The closer those emotions are to one another on the wheel, the more they have in common. For example, anticipation and joy both share an element of expectation, whereas fear and surprise share the quality of the unknown. Plutchik maintains that adjacent emotions blend to form the more complex feelings listed on the outer rim of the emotion wheel. Many of us would probably agree that love involves at least some elements of joy and acceptance, and that contempt certainly involves components of both anger and disgust.


(iStock)

According to Plutchik there are eight primary or basic human emotions, and all human emotions are variations or derivations of these eight.

8.3 Theories of Emotion

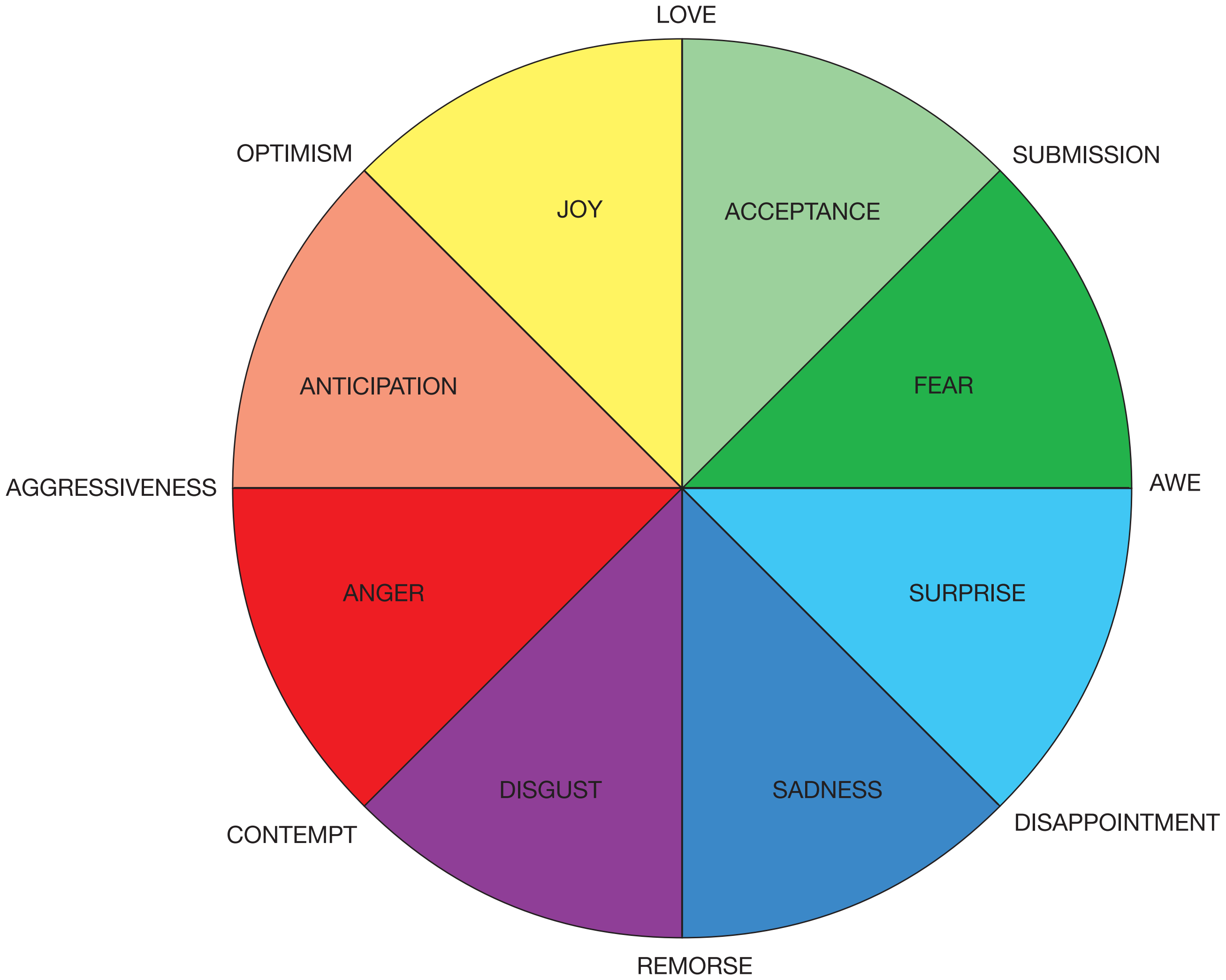
We have learned that emotional expression is a complex process involving cognitions, subjective feelings, physiological arousal, and behavioral reactions. How do these processes interact to produce an emotional response? What is the usual sequence of events? Is it necessary to think before we feel, or do we feel an emotion and then later interpret it as fear or happiness? Psychologists have proposed contradictory answers to these questions, in a controversy that sometimes resembles the well-known debate about whether the chicken or the egg came first. We examine the evidence as we review several historical perspectives as well as several contemporary theories of emotion.

8.3a The James-Lange Theory

Imagine that after having trouble sleeping, you decide to take a midnight walk. It is dark and still; no one else is in sight. Suddenly, you hear a rustling in the bushes behind you, followed by rapidly approaching footsteps. Your response will probably be one of terror. You are likely to run for your life.

Figure 8-1 Plutchik's Emotional Wheel

According to Robert Plutchik, there are eight primary human emotions consisting of four opposite pairs. Adjacent emotions (such as joy and acceptance) blend to form more complex emotions (like love).

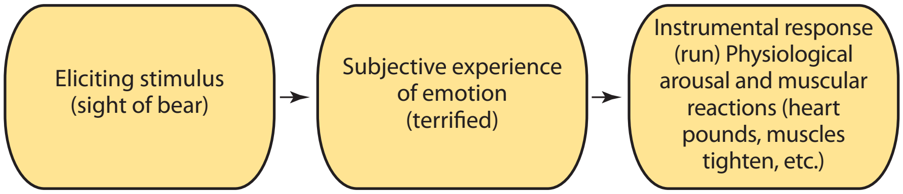


What would activate your feeling of fear in this situation? Is it triggered by the sounds you hear, which in turn induce you to run? Or is it more likely that your awareness of danger causes your heart to beat faster and your legs to carry you away, and that these physical responses trigger your emotional state, and you then feel fear? Decide which of these interpretations seems correct, and why, before reading on.

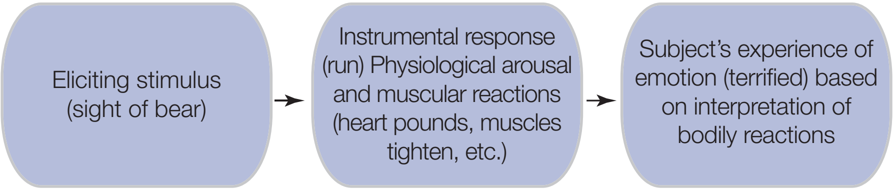
When such questions are put to students, the vast majority answer that hearing noises in the dark causes fear, which in turn triggers a flood of physical reactions. This "common-sense" interpretation of the activation of emotion seems quite logical (see Figure 8-2). We perceive and interpret a particular stimulus, in this case threatening noises; and these cognitive processes give rise to an emotion (fear), which triggers certain physiological responses and body movements. Along these lines, we would also conclude that we cry

Figure 8-2 Theories of Emotions

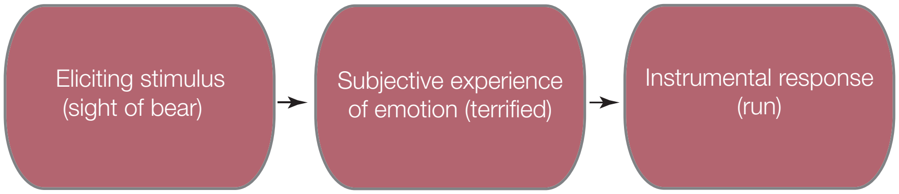
The "Commonsense" View of Emotion. We perceive and interpret a particular stimulus, and these cognitive processes give rise to an emotion that triggers certain physiological reactions and body movements. "I see a bear, feel fear, experience a flood of physiological reactions, and run because I am afraid."



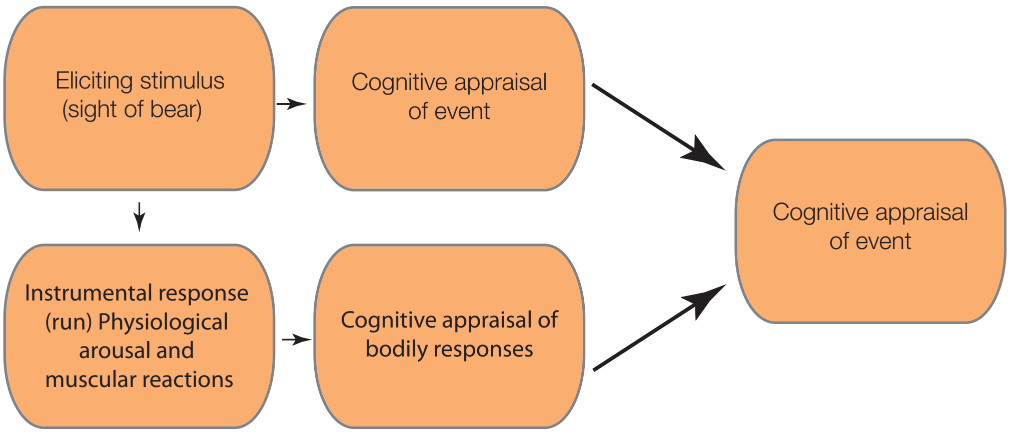
The James-Lange Theory. Environmental stimuli triggers physiological responses and bodily movements, and emotion occurs when the individual interprets his or her visceral and muscular responses. "I must be afraid because my heart is pounding and I am running like crazy."



The Cannon-Bard Theory. Emotion is a cognitive event that is enhanced by bodily reactions. Bodily reactions do not cause emotion but rather occur simultaneously with the experience of emotion. "I am afraid because I know bears are dangerous."



The Schachter-Singer Theory. Emotions depend upon a kind of double cognitive interpretation: We appraise the emotion-causing event while also evaluating what is happening with our bodies. "I am afraid because I know bears are dangerous and because my heart is pounding."



James-Lange Theory
Theory that explains emotional states (such as fear) resulting from an organism's awareness of bodily responses to a situation, rather than from cognitions about that situation

Cannon-Bard Theory
Theory that emotions occur simultaneously with physiological changes, rather than deriving from body changes as the James-Lange theory suggests

because we feel sad, rather than becoming sad because we cry, and that we laugh because we are happy, rather than being happy because we laugh.

However—writing independently of each other—the American psychologist William James (1884) and the Danish physiologist Carl Lange (1885), both questioned this common-sense view. Their interpretation, referred to as the **James-Lange theory**, suggests that environmental stimuli trigger physiological responses from viscera (the internal organs such as the heart and lungs). For instance, heart rate and respiration both increase. At the same time, the body may also respond with muscle movements, as when we jump at an unexpected noise. These visceral and muscular responses are our emotional states. This is followed by the feeling of the emotional state. Thus, James and Lange would argue that your fear stems from your sensory experience of specific emotional responses—a pounding heart, rapid breathing, running legs, and so forth—rather than from your cognitions about noises in the dark.

The James-Lange Theory assumes that we are able to discriminate subtle differences in physiological responses to distinguish among the wide variety of emotions we experience. While other theorists have challenged this assumption, psychologists today hesitate to reject the notion that people are able to discriminate between subtle differences in visceral and muscular patterns associated with specific emotions. Recent research has demonstrated that although different emotions are associated with similar physiological changes, these changes are not identical. For example, subtle distinctions have been demonstrated between emotions such as anger, fear, happiness, and sadness. These include variations in heart rate, resistance of the skin to the passage of a weak electrical current (galvanic skin response), temperature of the hands, patterns of activity in facial muscles, and neural activity in the cingulate cortex and the frontal lobes of the brain. More recent evidence demonstrating sensitivity to physiological responses comes from Pollatos et al., (2005) who demonstrated that individuals who were better at perceiving their own heart rate scored emotionally arousing stimuli more highly than subjects that were less sensitive to heart rates. Similarly, it is not uncommon for patients starting drug treatment for high blood pressure to report that they feel less anxious and stressed. Blood pressure medication lowered their blood pressure, which they had interpreted as stress and anxiety.

Certainly, these more recent findings do not prove the James-Lange theory, but it is possible that we are sensitive to a wide variety of these responses and that these changes serve as the basis for feelings of emotion (Damasio A., 2005).

8.3b The Cannon-Bard Theory

Walter Cannon not only criticized the James-Lange theory, he also proposed an alternate theory of emotion. Cannon argued that autonomic and muscular changes are not the cause of emotion. Instead, emotional experiences and physical changes occur simultaneously. This viewpoint, as modified by Philip Bard (1934), is known as the **Cannon-Bard theory**.

Cannon and Bard theorized that the thalamus (see Chapter 2) plays a key role in our emotional responses. It not only channels sensory input to the cerebral cortex, where it is interpreted but, at the same time, it also sends activation messages through the peripheral nervous system to the viscera and skeletal muscles. These activation messages trigger the physiological and behavioral responses that typically accompany emotions. Cannon and Bard would explain your emotional response to being approached in the dark in the following manner. The sensory input of the sounds you heard in the dark was relayed simultaneously to your cerebral cortex and your internal organs and muscles. This activity allowed you to perceive fear at the same time that your internal organs and muscles were reacting to the stimulus. Cannon and Bard would contend that when you feel fear, the emotion occurs at the same time as your pounding heart, rapid breathing, and flight from the source of the noise. James and Lange would suggest that your fear was caused by these physical changes. We will see that, while both theories are partially correct, both are incomplete.

More recent research has revealed that the hypothalamus, amygdala, and certain other structures in the limbic system (see Chapter 2) are the brain centers most directly involved in integrating emotional responses—not the thalamus. However, the Cannon-Bard theory should be credited with pointing out the important role of central brain processes in our emotional responses. The James-Lange theory, on the other hand, correctly identified the important role of peripheral, autonomic processes in emotion; and it proposed the distinction between feelings and emotions.

Both the James-Lange and Cannon-Bard Theories correctly stress the importance of physiological process in emotion. Neither theory, however, proposes a significant role for cognition. Another theory, known as the Schachter-Singer theory, presents an interesting assessment of the role of appraisal or judgment (cognitions) in our ability to correctly identify a variety of emotions from very few distinct physiological states.

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8.3c The Schachter-Singer Theory

In the early 1960s, Stanley Schachter and Jerome Singer (1962) developed the **Schachter-Singer theory** of emotions, which combined elements from both the James-Lange and the Cannon-Bard theories. Schachter and Singer believed that emotion follows behavioral and physiological reactions and that, in addition, cognitive processes were central to emotional experience.

Schachter and Singer proposed that we appraise the emotion-causing event while evaluating what is happening with our bodies. The key process in emotional arousal is how we interpret physiological feedback in light of our present situation.

For example, suppose you have just run several blocks across campus to avoid being late to a class. You probably note that you are panting and sweating and that your heart is pounding, but you are unlikely to experience an emotional response to these heightened physical reactions. If you experience these same physical responses under different circumstances, however—for example, while running across a farmer's field to escape an enraged bull—you would probably interpret your arousal as fear.

The James-Lange view proposed that a given state of bodily reaction and arousal produces a specific emotion. Schachter and Singer suggested that a given physiological state could produce a variety of emotions, depending on the context within which it occurs. From this point of view, we might interpret highly similar patterns of arousal as reflecting distinctly different emotions in different contexts.

The Schachter-Singer theory has directed the attention of psychologists to the important role of cognitive interpretation in emotional experience. However, Schachter and Singer's theory and supporting research are not without their critics. Several researchers have criticized the design of the classic 1962 experiment, and some attempts to replicate its findings have produced somewhat inconsistent results (Leventhal & Tomarken, 1986; Marshall & Zimbardo, 1979). Furthermore, our own everyday experiences suggest that many emotions, particularly those that are triggered spontaneously and instantly by sudden stimuli, do not appear to result from interpreting and labeling unexplained arousal. For example, if you heard screeching tires as you were walking across a street, you would probably experience fear long before you had cognitively assessed why your heart was in your throat. In conclusion, the Schachter-Singer theory has lost favor among researchers investigating emotion over the last few decades. Modern neuroimaging

Schachter-Singer Theory
Theory that a given body state can be linked to a variety of emotions depending on the context in which the body state occurs

studies, on the other hand, seem to provide more and more support for the James-Lange theory of emotion.

8.3d The Function of Emotional Expression

Charles Darwin in the late nineteenth century (1872) was one of the first to write extensively on the function of emotional expression. According to Darwin, each emotional "state of mind" was associated with a stereotyped set of reactions that were common within each species. In addition, emotional states that were essentially opposite were associated with an opposite set of reactions. For instance, in greeting its master a dog displays a submissive posture like that shown in the top illustration in Figure 8-3a. This set of reactions is opposite to those displayed in the aggressive posture shown in the second image in Figure 8-3a.

Can you think of reasons why opposite emotional states are displayed with essentially opposite postures? What selective advantage might this have? Darwin believed that the behavioral expression of emotions allowed animals to communicate different emotional states and the advantage of opposite postures for opposite emotional states was that this minimized the possibility of emotional states being confused. Because there are few, if any, postural similarities between aggressive and submissive postures, they are unlikely to be treated similarly.

Darwin also believed that many human emotional expressions, particularly patterns of facial display, result from inherited traits that are universal in the human species. Enlisting the aid of missionaries and other people from all over the world, he conducted the first recorded study of facial expression of emotions. Darwin asked his recruits to observe and record the facial expressions of the local population in a variety of emotional contexts. Comparing their observations, he found a remarkable consistency in the facial expressions associated with such emotions as anger, fear, disgust, and sadness. Darwin interpreted this as evidence of the inheritance of emotional expression.

8.3e Facial Feedback and Emotions

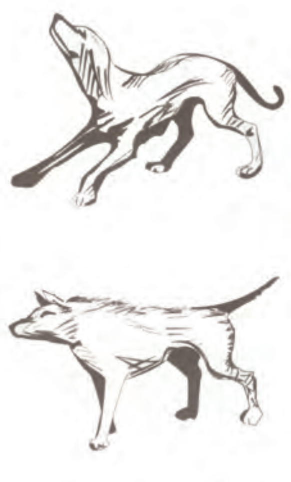
Darwin's findings were borne out a century later in studies by Paul Ekman and his associates (Ekman P., 1982; Ekman & Friesen, 1984). These researchers demonstrated that people in various parts of the world not only show emotion with similar facial expressions they also interpret these expressions in the same way. Ekman and his colleagues took photographs of American faces depicting happiness, anger, sadness, surprise, disgust, and fear. (Figure 8-4 shows examples of these six emotions.) They then asked people from several different cultures (including the United States, Japan, Brazil, Chile, Argentina, and the Fore and Dani tribes in remote regions of New Guinea) to identify the emotions shown in the photographs. People from all of these cultures were able to identify the emotion from the facial expression with better than 80 percent accuracy. Furthermore, American college students who viewed videotapes of emotions expressed facially by members of the Fore Society were also able to identify these basic emotions, although they sometimes confused fear and surprise.

A number of researchers have argued that facial muscles respond very rapidly and with sufficient differentiation to account for a wide range of emotional experience; some have theorized that feedback from our own facial expressions determines our emotional experiences. This is now known as the **facial feedback theory** of emotion.

Facial Feedback Theory
Proposes that feedback from facial muscles intensifies the feeling of an emotion

Figure 8-3 Emotional Expressions in Animals

a. Emotional expression in dogs. Note that opposite postures represent opposing emotions.



b. Emotional expression in chimpanzees. These illustrations show the facial expressions of chimpanzees:

(a) glaring anger	(e) fear-affection	(i) crying
(b) barking anger	(f) affection	(j) eaxcitement
(c) fear	(g) frustration	(k) playfulness
(d) submission	(h) sadness	

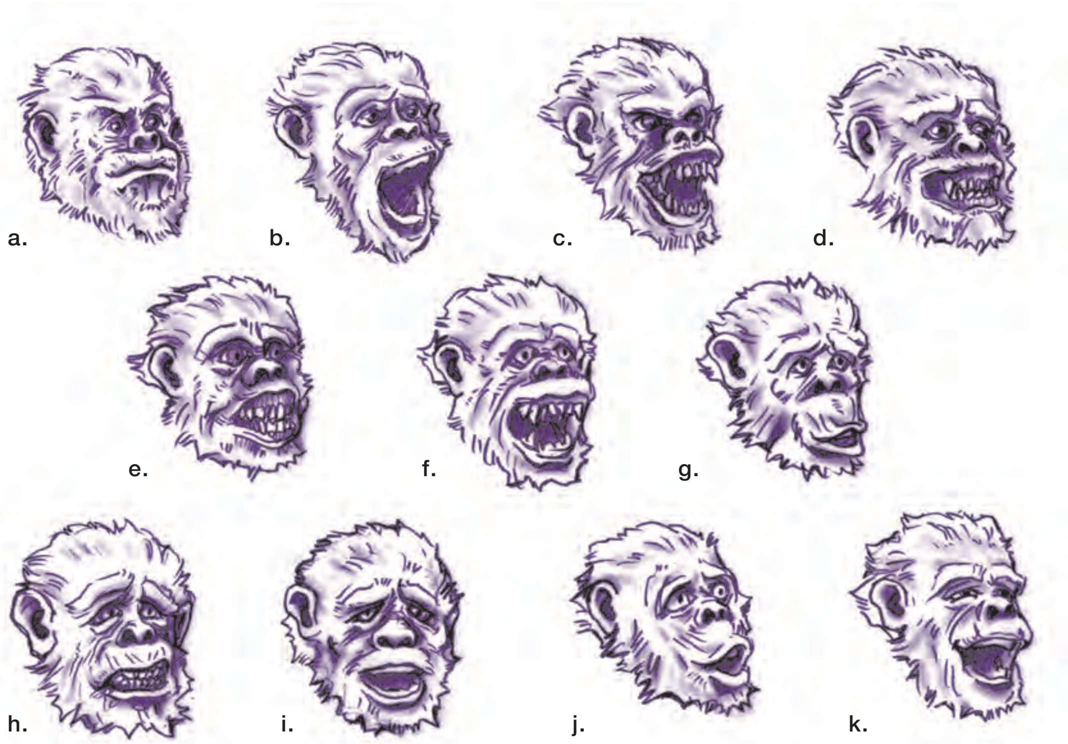
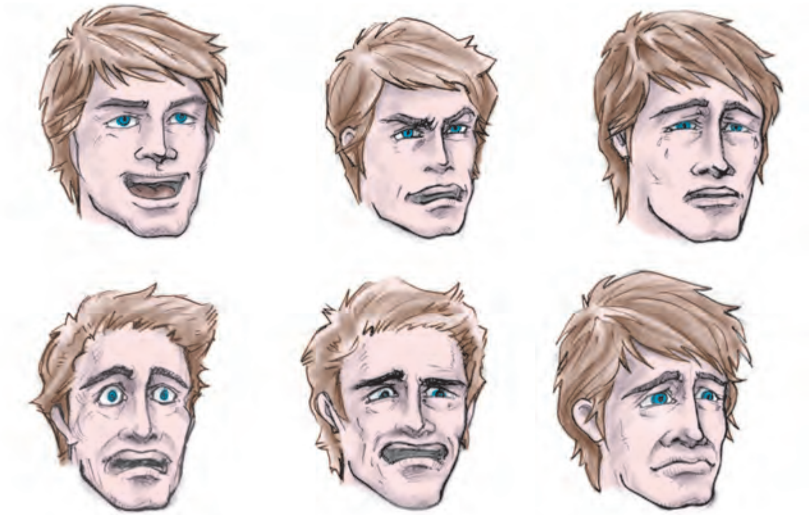


Figure 8-4 Facial Expressions Used by Paul Ekman

The faces, from left to right, were intended to represent happiness, anger, sadness, surprise, disgust, and fear.



The notion of universal facial expressions was supported by the cross-cultural research just discussed, and further support was provided by an intriguing two-part experiment conducted by Paul Ekman and his associates (1983). Here, professional actors were employed as subjects. In the first part of the experiment, each subject was coached, with the aid of a mirror, to assume a specific facial expression corresponding to each of the six emotions in Figure 8-4. They were told exactly which muscles to contract, but they were not asked to feel or express a particular emotion. As a control measure, some actors were coached to move muscles not involved in a particular emotional expression. As the subjects molded their facial expressions, several physiological responses were measured, including heart rate, galvanic skin response, temperature of the hands, and muscle tension in the arms. In the second phase of this experiment, subjects were simply asked to think of emotional experiences in their lives that produced each of the six emotions. For example, subjects might recall a recent encounter that made them angry.

Two major findings emerged from this study. First, the researchers noted that each of the four negative emotions of anger, fear, disgust, and sadness, whether induced by facial modeling or thinking of an emotional experience, was accompanied by a distinct physiological "fingerprint" or pattern of physical responses. For example, heart rate was much greater in anger than in disgust, and the hands were colder in fear than in anger. Table 8-1 shows the increases or decreases in heart rate and skin temperature for each of the six acted emotions. Ekman's findings seem to support James and Lange's assertion that different emotions are associated with distinct patterns of physiological response.

Table 8-1 Heart Rate and Skin Temperature

Both heart rate and skin temperature were associated with different acted emotions in Ekman's experiment.

Specific Emotion	Change in Heart Rate (Beats/Min.)	Change in Skin Temperature (Degrees C)
Anger	+ 8.0	+.16
Fear	+ 8.0	– .01
Distress	+ 6.5	+ .01
Joy	+ 2.0	+ .03
Surprise	+ 1.8	– .01
Disgust	– 0.3	– .03

The second, and perhaps the most intriguing finding in this experiment, is that when the subjects simply followed instructions to move their facial muscles to mirror a given emotion, they also experienced patterns of physiological arousal that were comparable to those recorded when they relived an actual emotional experience. In some instances, the physiological signs of emotion were more pronounced when the subjects merely moved their facial muscles than when they thought of an emotional experience.

Can you think of a possible application of the research findings of Paul Ekman and his colleagues? Might this information be applied to enhance our emotional lives? Think about this question for a moment or two before reading on.

Ekman's findings do have some practical implications. We have all heard the sage advice to "keep our chins up" or to "put on a happy face" when we are feeling sad or depressed, and this research suggests that there may be some validity to this advice. Subjects felt happy just by contracting the facial muscles associated with happiness. Perhaps if we make the effort to act cheerful, smile, and laugh when we feel down in the dumps, we will in turn feel more cheerful and less sad.

In the preceding studies subjects were instructed to alter facial expressions voluntarily while researchers attempted to measure their emotional experiences. Researchers are now beginning to utilize another approach. The widely used cosmetic drug Botox reduces wrinkling by paralyzing facial muscles. If facial feedback contributes to our emotional experiences, wouldn't patients using Botox experience emotions differently? Several researchers have now begun to examine this with surprising results. Research conducted by Davis et al, (2010) and Havas et al., (2010) suggests that patients do in fact experience emotions with less intensity after Botox injections than prior to treatment. Using functional imagery (*f*MRI) (Hennenlotter, Dresel, Castrop, Ceballos, & Wohlschlager, 2009) demonstrated that paralyzing facial muscles with Botox actually diminished brain activity in the emotional circuits of the brain. These results all tend to support the decades-old idea that feedback from facial muscles contributes to the intensity of our emotional experiences.

Kluver-Bucy Syndrome A pattern of emotional deficit seen after damage to the amygdala

Central Nucleus of the Amygdala Region within the amygdala that integrates sensory information related to fear and aggression and sends output to numerous parts of the body for emotional responses

8.3f The Neurobiology of Emotions

In the preceding sections we have seen that emotions and their corresponding feelings involve a number of physiological processes and brain structures. In this section we will examine several of the most important neural structures for emotion and clarify their roles in the different components of emotion described at the outset. Much of this research comes from animal studies of fear and aggression, but we are beginning to learn much more about more positive emotions such as happiness and love from human studies. Any discussion of fear and aggression must begin with the amygdala.

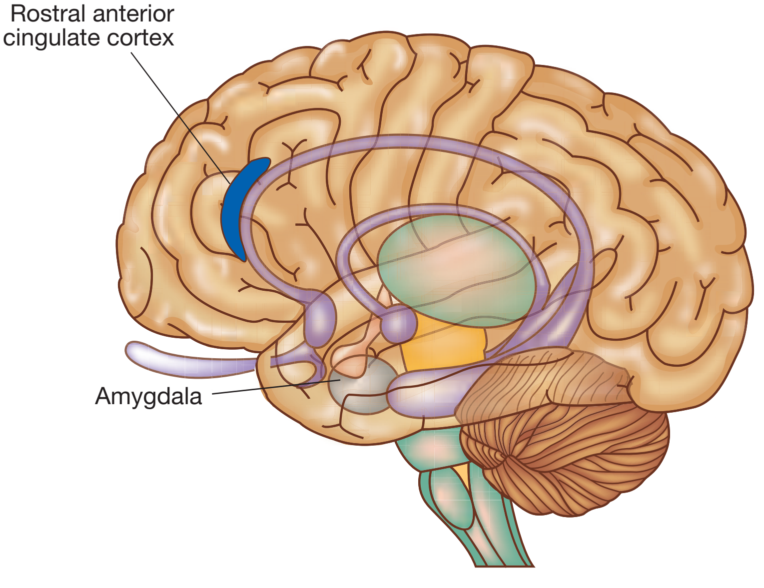
The Amygdala and Cingulate Cortex

The amygdala is located deep within the temporal lobes of both hemispheres of the brain. It is composed of several distinct regions that receive and transmit potentially harmful information about the environment to other brain structures to activate all components of fear and aggression. Early surgical studies demonstrated that damage to the amygdala and its surrounding regions severely disrupted all aspects of emotional responding (Kluver & Bucy, 1939). Animals with this damage demonstrated hyper reactivity, deficits in emotional expression, and hyper sexuality. This pattern of emotional loss is known as the **Kluver-Bucy Syndrome**. More recent studies have elaborated on the role of the amygdala in conditioned fear and found that anxiolytic drugs diminish anxiety through actions within the amygdala as well (Davis, 1992; LeDoux, 1992).

The **central nucleus of the amygdala** regulates all aspects of emotional behavior including sympathetic activation, increased respiration, behavioral arousal, facial expressions, and hormone release. It also sends signals to several cortical structures

Figure 8-5 The Amygdala and Cingulate Cortex

Locations of several neural structures essential for the expression and feeling of emotions.



(Carlson, 2011). While the amygdala controls emotional behaviors, it is the cortex that interprets these emotional states as specific feelings and gives us our awareness of them. Several structures appear to interpret emotional states and their body sensations into feeling states (Damasio A., 2004). Human patients with damage to their **cingulate cortex** express emotions, but they do not recognize feelings associated with them. That is, they can be provoked into anger, but do not feel angry, and they do not recognize emotion expressions in themselves or others.

Cingulate Cortex Area of the cortex deep in the midline that interprets emotional responses as a feeling state

Opponent-Process Theory of Emotion Theory that when a strong emotional response to a particular stimulus disrupts emotional balance, an opposite emotional response is eventually activated to restore emotional equilibrium

8.3g Opponent-Processes and Motivation

The author has a brother who is an avid rock climber. Some years ago he experienced a climbing accident that almost ended his life. However, he is now back rock climbing with just as much zest and enthusiasm as before, perhaps even more. What accounts for his continued participation in a sport that must arouse intense emotion at both ends of the scale—both high fear and ecstatic exhilaration? For that matter, why do people jump out of airplanes with a parachute strapped on their backs, shoot the rapids of wild rivers, ski off extremely steep mountain slopes, or return to a sport that almost killed them?

Some years ago psychologists Richard Solomon and J. D. Corbit (1974) proposed a theory of emotion that attempts to answer these questions. According to their **opponent-process theory of emotion**, people are inclined to maintain a relatively even keel or balance in their emotional lives. When a strong emotional response to a particular stimulus event disrupts this homeostatic balance, an *opponent-process*, or opposite emotional response, is eventually activated to restore equilibrium in our emotional state. Thus, if our initial response to being confronted with class-4 (wild water) rapids is sudden terror, we will probably subsequently experience elation after successfully negotiating the rapids—a positive or opposite emotion that cancels out the original negative emotion, thus restoring us to a neutral or balanced emotional state.

From this perspective, emotions are viewed as possessing *hedonic value,* which is to say they vary from being extremely positive or pleasant to being very negative or unpleasant (Solomon R., 1980; 1982). When an emotion of a particular hedonic value is aroused, it will be followed shortly by its hedonic opposite. Thus, when we are elated we can expect that this emotion may eventually give way to feeling somewhat down or depressed. Likewise, fear is replaced with elation (or at least relief), pain with pleasure, anxiety with calm, boredom with interest, and so forth.

Solomon and Corbit theorized that under normal conditions, when we encounter a particular emotion-arousing stimulus only now and then, the opponent emotional states would be sufficiently equalized in intensity to balance each other out. Thus if we go rock climbing only once each year, we can expect to continue experiencing the same relative intensities of high terror and elation that serve to balance our emotional equilibrium. However, what happens if we become avid climbers after our initial encounter with this exhilarating sport? Solomon and Corbit would argue that when we repeatedly expose ourselves to a situation that arouses the same intense emotion, our initial emotional reaction would gradually weaken over time while the opponent emotional reaction would grow stronger. Therefore, we can expect that our terror of heights will gradually diminish to a level of anxiety just sufficient to get the adrenaline pumping. In contrast, our euphoria after successfully negotiating a steep pitch could be expected to become more intense or powerful as time goes on.

This weakening of the initial emotional response together with the eventual dominance of the opponent-process emotion explains why river runners, rock climbers, skydivers, race car drivers, and other risk takers find that the more they engage in their

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thrilling sports the more enjoyable these activities become. The opponent-process theory has also been used to explain addiction to certain addictive drugs like nicotine, heroin and cocaine (Ettenberg, Raven, Danluck, & Necessary, 1999; Ettenberg A., 2004; Knackstedt, Samimi, & Ettenberg, 2002; Koob & Le Moal, 2008; Watkins, 2000). Most people experience intense pleasure and an emotional high during their initial exposure to cocaine. However, as any addict can attest, the pleasure associated with using this drug typically decreases with repetitive use. Animals, for example, will initially seek the location where cocaine is administered, but later avoid that location. This is additional evidence that the motivation to seek the drug is eventually replaced by motivation to avoid withdrawal (see Figure 8-6).

This drug-related phenomenon stands as stark testimony to Solomon's observation that people who seek pleasure often pay for it later, and that with repeated pleasure seeking the pleasure itself often loses much of its intensity. Of course, as previously noted the reverse is also true: In that the fear component of risky, thrill-seeking activities often diminishes over time as exhilaration and euphoria intensify with each additional experience. It is in this way that the opponent-process theory accounts for the apparent shift in motivation for many activities. For instance, the motivation to use drugs the first few times may be the intense euphoria associated with those drugs. Later, the motivation shifts to the avoidance of the aversive nature of drug withdrawals.

In concluding our discussion of emotion, we must acknowledge that many questions remain to be answered. While there is renewed support for the James-Lange Theory, no one theory of emotion will encompass all aspects of emotion and its expression. In the next section we will examine one emotion, stress, and its relation to our well-being in more detail.

8.4 Stress

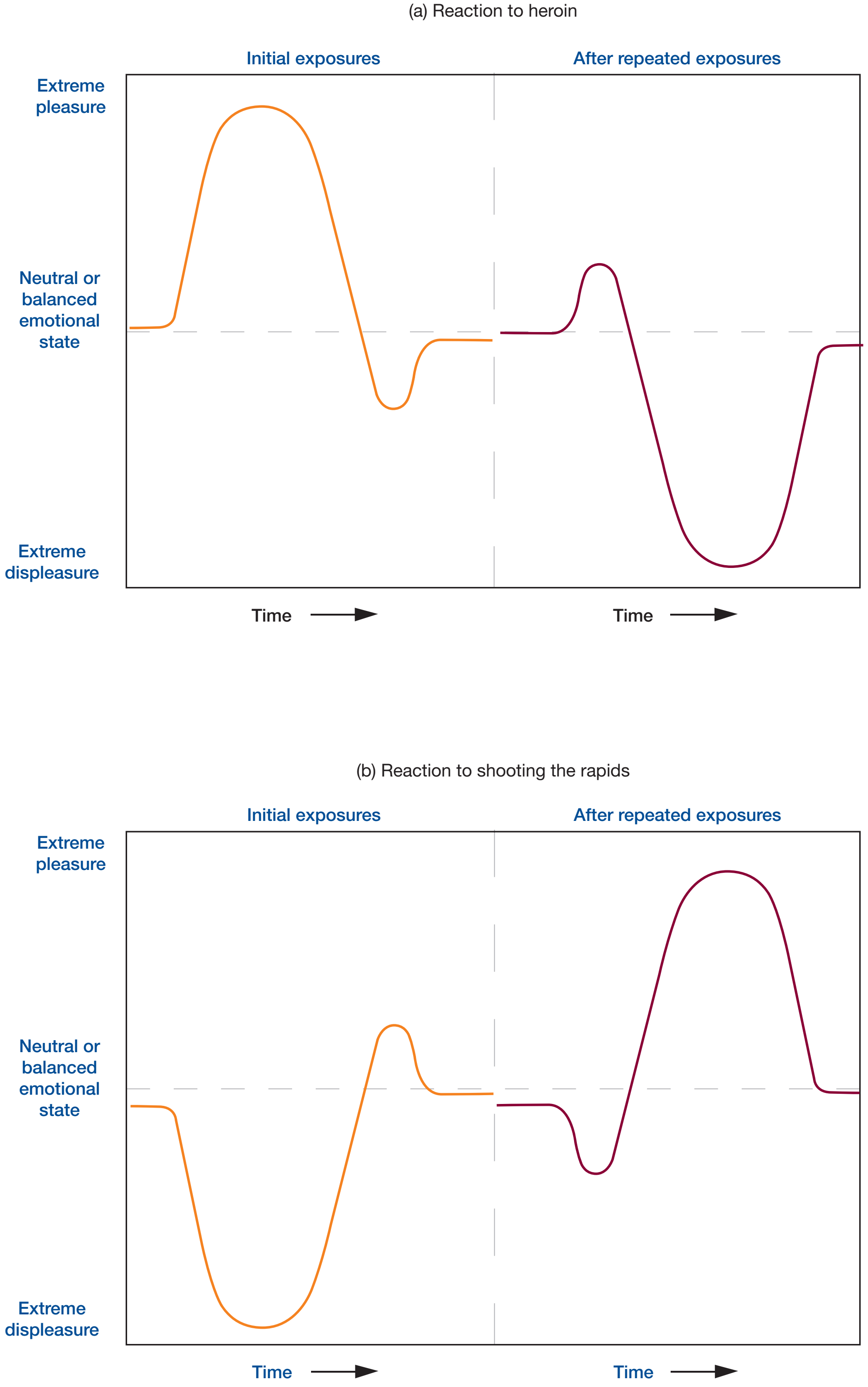
We have all learned that negative emotions such as fear, anxiety, anger, and depression often exact a price in our lives in the form of impaired functioning, fatigue, symptoms of physical discomfort, and even illness. Disruptive, unpleasant emotions play a major role both in contributing to stress and as key components in the manifestation of reactions to stress. Thus we end this chapter with a somewhat detailed discussion of the topic of stress, including comments about the nature of stress and stressors, physiological and psychological responses to stress, and the relationship between stress and illness.

8.4a The Stress Response

Although we are all familiar with stress, it is an elusive concept to define. One reason for this is that stress means so many different things to different people, researchers, and laypersons alike. Some of us think of stress as sweaty palms, a fast-beating heart, gritted teeth, and a churning stomach. Consistent with this impression, researchers have for many years focused on the physiological changes that accompany stress. More recently, however, the study of stress responses has been expanded to include emotional, cognitive, and behavioral changes as well as physical reactions. When we are feeling stressed, we may be more inclined to describe our condition as being unprepared for an exam, feeling crowded in our dorms, or being harassed by a supervisor on the job, rather than focusing on our bodily or psychological responses.

Figure 8-6 Opponent-Process

Part (a) demonstrates how, with repeated use of heroin, the pleasure decreases while the displeasure associated with withdrawal increases. Part (b) portrays the likely response of a river runner as he repeatedly shoots the rapids. Each encounter with this sport may result in decreased fear and an increase in the pleasure associated with it.



Most contemporary researchers believe that an adequate definition of stress must take into account the interplay between external stressors and our physical and psychological responses. This relationship is neither simple nor predictable because it varies from person to person and from day to day. As we see later in our discussion, this variation occurs because stress is inextricably connected to our cognitive appraisals of events (Lazanis & Folkman, 1984; Lazarus, 2001). According to Lazarus, **stress** is the process of appraising events (as harmful, threatening, or challenging), of assessing one's potential to control or cope with the event, and continuing reappraisal as new information becomes available. Appraisal and reappraisal do not always result in less stress; they may actually lead to an increase in stress if coping strategies are not effective or available. In the following paragraphs we examine physiological and psychological responses to stress as well as the situations that produce stress. We then explore what we know about the role stress plays in some common illnesses.

8.4b Physiological Responses to Stress

In the 1930s the Canadian researcher Hans Selye was conducting research that he hoped would lead to the discovery of a new sex hormone. The leads were promising. When he injected rats with extracts of ovary tissue, the results were consistent: Bleeding ulcers in the stomach and small intestine, enlargement of the adrenal cortex, and shrinkage of the thymus gland. Since no hormone was known to produce these effects, Selye was convinced that he was on the track of identifying a new one. His elation was quickly dampened, however, for when he injected extracts from other tissues, the effects were identical. Furthermore, the same thing occurred when he injected toxic fluids that were not derived from tissues.

Selye was devastated by this turn of events. However, instead of giving up, he tried to figure out what had happened. The answer occurred to him only when he stopped trying to relate his findings to the discovery of a new sex hormone. In his own words,

> *It suddenly struck me that one could look at [my ill-fated experiments] from an entirely different angle. [Perhaps] there was such a thing as a single nonspecific reaction of the body to damage of any kind. (1976, p. 26)*

Selye went on to study how animals responded to a wide range of stressful events other than injections. He exposed rats to a variety of adverse conditions—such as extreme cold and fatigue, electric shock, immobilizing restraint, and surgical trauma—and noted the same physiological response pattern as he had originally observed with injections of tissue extracts. As we see later in this chapter, Selye also learned that humans respond to stress with fairly consistent physiological patterns (1936, 1956, 1974, 1976). The awareness that stress can have harmful effects on our bodies has led to many more studies, as well as techniques for reducing the impact of stress on our own lives.

Hans Selye's observations of how his rats responded to stressors led him to formulate the concept of the **general adaptation syndrome (GAS)**. According to this notion, when an organism is confronted with a stressor, its body mobilizes for action. This mobilization effort is mediated by the sympathetic nervous system as we saw in Chapter 2, and it works primarily through the action of specific stress hormones on the body's muscles and organ systems. The response to stress is *nonspecific*, for the same physiological reactions occur regardless of the stressor. Selye also noted that repeated or prolonged exposure to stress that is not adequately managed or reduced results in tissue damage (such as bleeding ulcers), increased susceptibility to disease, and even death in extreme cases.

Stress A pattern of hormonal and physiological responses that accompany threatening events

General Adaptation Syndrome (GAS) Progressive responses to prolonged exposure to stressful events during which an organism mobilizes for action and compensates for stress

Alarm, Resistance, and Exhaustion

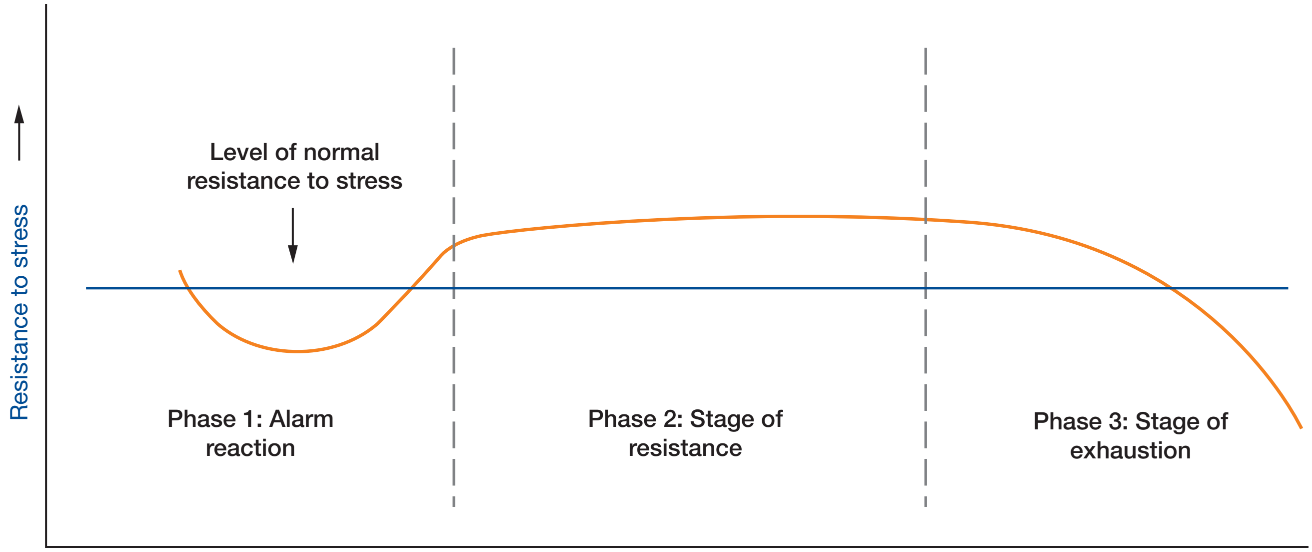
Selye described three phases of the general adaptation syndrome: alarm, resistance, and exhaustion (see Figure 8-7). When an organism is exposed to a stressful event, it first experiences an alarm reaction in which it mobilizes to meet the threat. A sudden arousal of the sympathetic nervous system produces a flood of stress hormones—corticosteroids from the adrenal cortex and epinephrine (often called adrenaline) and norepinephrine from the adrenal medulla.

These hormones prepare the body for "fight or flight" by producing a number of physiological reactions. First, our heart rate is likely to increase, as is blood pressure. This activity forces blood to parts of the body that may need it for strenuous physical activity such as flight away from danger. We experience this response as a pounding heart, like the rapid-fire thumping you may have felt after barely avoiding an accident on the freeway. Sugars and fats also flood the blood to provide fuel for quick energy. This emergency response provides extra reserves, with the result that people are often able to perform seemingly superhuman feats (such as lifting a heavy beam off a person trapped in a mine cave-in) that they could not otherwise perform. Digestion slows or ceases during the alarm stage, making more blood available to the muscles and brain.

Our breathing rate also accelerates to supply increased oxygen to muscles poised for greater than normal output. Thus people often have difficulty catching their breath after a severe fright. Still another response to stress is a tensing of the muscles in preparation for an adaptive response. This explains the stiff neck, sore back, and painful aching legs that many people experience after a long, hard exam or a rough day at work.

We also tend to perspire more when under stress—a response that acts as a kind of built-in air conditioner that cools our energized bodies. It also allows us to burn more energy (which produces heat) when we are faced with emergency situations. This is why many people find themselves drenched with perspiration after giving a speech or undergoing a stressful interview.

Figure 8-7 Three Phases of Selye's General Adaptation Syndrome (Adapted from Selye, 1956.)



Finally, clotting agents are released into the blood when we are under stress, so that our blood will clot more rapidly if we are injured. One reason why we may not notice an injury we receive during an accident or fight is because the wound may have bled very little. Table 8-2 summarizes these responses to stress.

We are not able to maintain the alarm phase's high level of bodily response or sympathetic activity for very long. Eventually the parasympathetic nervous system comes into play, providing a braking mechanism for the organs activated by the sympathetic system. At this point the organism enters into the second stage of resistance. Now the body continues to draw upon resources at an above-normal rate, but it is less aroused than in the alarm state.

If the stress is prolonged or repeated, an organism is likely to enter the third stage of exhaustion. As a direct result of the continued drain on resources, the body tissues may begin to show signs of wear and tear during the exhaustion stage. Susceptibility to disease also increases, and continued exposure to the stressor is likely to deplete the organism's adaptive energy. The symptoms of the initial alarm reaction are likely to reappear, but resistance is now decreased, and the alarm reaction is likely to continue unabated. If the organism is unable to develop strategies to overcome or cope with stress, serious illness or even collapse and death may result.

Selye's model has had a profound impact on our understanding of stress and its links to illness. It not only provides a way of conceptualizing our physiological response to events in the environment, it also provides a plausible explanation for the relationship between stress and disease. Few medical experts today disagree with Selye's basic contention that prolonged stress will often produce bodily wear and tear and erode our ability to resist disease if it is not effectively coped with. However, Selye's theory has also been criticized on a few counts. One criticism is that Selye failed to acknowledge the important role of psychological factors in stress responses; for example, the significant role of cognitive appraisal in determining the extent to which we assess a particular environmental event as stressful. Furthermore, some newer evidence suggesting that particular stressors may be associated with distinctly different physiological responses calls into question Selye's assumption of nonspecificity in reaction to stress. For example, exercise stress produces a pattern of physiology quite different from emotional stress (Dinsdale & Moss., 1980).

Table 8-2 Some Physiological Responses to Stress

• Heart rate and blood pressure increase, forcing blood to parts of the body that may need it for strenuous physical activity
• Digestion slows or ceases, so that more blood is available to other organs
• Breathing rate accelerates to provide increased oxygen to bloodstream
• Muscles tense in preparation for an emergency response
• Perspiration increases, acting to cool the body
• Clotting agents are released in the blood to prevent loss of blood in case of injury

8.4c Stressors

We have been looking at the ways we respond to stress, but so far we have said relatively little about the situations or events that produce stress in our lives. Are some kinds of events more likely to cause stress than others? Are stressors always negative events? We explore these questions next.

Factors that Contribute to Stress

Our cognitive assessments have a lot to do with the degree of stress an event will produce in our lives, but it is not true to say that all events have the same potential for eliciting stress. What characteristics increase the likelihood that we will perceive an event as stressful?

Lack of Control One of the most important factors that contribute to the stressfulness of a situation is our lack of control over it. Thus, it is much less stressful for you to stick a needle into yourself (for example, when removing a splinter) than to have a physician stick a needle into your arm. Research reveals that uncontrollable or unpredictable events are generally more stressful than those we can control or predict. You might think that certain experiences, such as excessive noise, a nagging parent, or a series of painful rehabilitative exercises after a serious accident, would be stressful for anybody exposed to these events. This conclusion is not necessarily warranted, however. When people believe that they can predict, modify, or end an unpleasant event, they are likely to experience it as being less stressful (even if they take no action to modify it). The knowledge that something can be done may be sufficient to reduce the stress. Numerous experiments with laboratory animals support this argument.

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When we feel stressed, we may be more inclined to describe our condition in emotional terms rather than focusing on our bodily or psychological responses.

Suddenness A second variable influencing how stressful we perceive an event to be is the suddenness with which it overtakes us. When people experience accidents, the sudden death of a loved one, or an unexpected pink slip at work, they may find it very difficult to mobilize adequate coping mechanisms. In general, it is easier to cope with challenges that we can foresee. Thus a person who loses a loved one after a protracted illness, or who loses a job after expecting to be terminated for months, may be much less stressed by these aversive events.

Ambiguity In general, a stressor that we perceive as ambiguous is likely to induce more stress than one that is clear-cut. In well-defined situations we may be able to determine an appropriate course of action (fight, flight, or adapt), but ambiguity forces us to spend resource-depleting energy trying to figure out the nature of the stressor and possible strategies to cope effectively with it. Research demonstrates that role ambiguity is a major cause of stress on the job. If you have a job in which your role is not clearly defined so that you do not know what is expected of you, you are likely to experience far more stress than if your employer's expectations are made clear.

8.4d Stress and Disease

Most of Selye's work focused on endocrine responses to stress in nonhuman animals, most notably rats. In recent years, however, increased attention has been directed to assessing the importance of psychological factors in stress reactions. It is now widely recognized that stress and the corresponding physiological changes that underlie it have profound effects on our health and well-being.

Stress is widely recognized as a major factor in a wide range of physical illnesses. It has been estimated that as many as three out of four visits to physicians are prompted by stress-related problems. Furthermore, stress and stress-related behaviors may be the leading contributors to early death.

Table 8-3 compares the leading causes of death in the United States in the early 1900s and in 2010. The major health problems of the early 1900s were infectious diseases vv(numbers 2, 3, and 4 in the table are all infectious diseases and total 539 per 100,000), followed by cardiovascular diseases. Today the leading health problems are no longer infectious diseases but cardiovascular diseases, cancers, and strokes. Although these diseases are not new, the proportion of people who die from them has increased dramatically since 1900. Most importantly, these are all diseases that, in some part, can be attributed to individual behavior and lifestyle; and all of them have been linked to stress. This stress link may be direct through impaired immune function or indirect through cigarette smoking, excessive drinking, poor diet, and/or lack of exercise. In this section we explore the evidence linking stress with several physical disorders: Coronary heart disease, hypertension, infectious diseases, and cancer.

Table 8-3 The Eight Leading Causes of Death in the United States, 1900 and 2010 (rates per 100,000 population)

1900	Rate	2010	Rate
1. Cardiovascular diseases (heart disease, stroke)	345	1. Cardiovascular diseases (heart disease, stroke)	228
2. Influenza and pneumonia	202	2. Cancer	189
3. Tuberculosis	194	3. Chronic obstructive pulmonary diseases	44
4. Gastritis, duodentitis, and colitis	143	4. Accidents	40
5. Accidents	72	5. Influenza and pneumonia	31
6. Malignant neoplasms	64	6. Diabetes	25
7. Diphtheria	40	7. Liver disease	24
8. Typhoid fever	31	8. Alzheimer's	22

Figures for 1900 from Historical Statistics of the United State: Colonial Times to 1970, U.S. Bureau of the Census, 1975, Washington DC, U.S. Government Printing Office. Figures for 2012 National Vital Statistics Report.

Heart Disease

Coronary Heart Disease (CHD) is a general label for illnesses that cause a narrowing of the coronary arteries, the vessels that supply the heart with blood. CHD accounts for nearly 40 percent of all deaths in the United States each year (American Heart Association, 2012), many of which occur when people are still in the prime of life. Millions of Americans also experience reduced quality of life as a result of the ravages of CHD.

While factors such as smoking, obesity, diabetes, family history, diets high in fat, high serum cholesterol levels, physical inactivity, and high blood pressure are all linked to CHD, these risk factors considered together account for less than half of all diagnosed cases of CHD (American Heart Association, 2012). Something else besides genetics, diet, exercise, and general health habits must be a factor in CHD; and research over the last three decades has strongly implicated stress.

The story of how stress was first linked with heart disease begins with an unexpected discovery by cardiologists Meyer Friedman and Ray Rosenman (Freidman & Rosenman, 1974). In the late 1950s, Friedman and Rosenman were studying the relationship between eating behavior and disease among a sample of San Francisco couples. They found that although the women consumed amounts of cholesterol and animal fat equal to those consumed by their husbands, the women were dramatically less susceptible to heart disease than the men in the study. Since most of the men were employed and their wives were not, Friedman and Rosenman began to suspect that job-related stress might be implicated in the sex differences in CHD. Following up on this hunch, they mailed questionnaires to hundreds of physicians and business executives, asking them to speculate about what had caused the heart attacks of their patients, friends, and colleagues. Their responses overwhelmingly blamed job-related stress.

The next step was to conduct a field study. A sample of forty tax accountants was studied over several months, commencing at the first of the year. During the first three months, laboratory measures of two warning indicators, blood-clotting speed and serum cholesterol levels, were generally within the normal range. This changed, however, as the April 15 tax-filing deadline approached. During these few weeks the accountants were under a great deal of pressure to finish their clients' tax returns, and both blood-clotting measures and serum cholesterol rose to dangerous levels. Once the tax-filing crunch passed, both measures returned to normal.

Convinced that responses to stress may be major contributors to coronary heart disease, Friedman and Rosenman embarked on a nine-year study of several thousand men, ages 35 to 39, who were physically healthy at the outset of their investigation. Each subject was asked specific questions about his work and eating habits and his usual ways of responding to stressful situations. Using subjects' responses, as well as observations of their behavior, the researchers divided participants into two groups roughly equal in size. Subjects in the **Type A** group tended to be hard-driving, ambitious, very competitive, hostile, easily angered, very time conscious, and demanding of perfection in both themselves and others. In contrast, **Type B** subjects were relaxed, easygoing, not driven to achieve perfection, happy in their jobs, understanding and forgiving, and not easily angered (Friedman & Ulmer, 1984; Freidman & Rosenman, 1974).

By the end of the long-term study, it was clear that Type A subjects were far more prone to heart disease than their Type B counterparts. Over the nine-year period, 257 subjects in the total research population had suffered heart attacks, and approximately 70 percent of these were Type A. In other words, Type A subjects were more than twice as vulnerable as Type B. More recent research, however, has failed to consistently demonstrate a connection between Type A behaviors in general and CHD risk. Evidence now suggests that specific components of Type A behavior, like hostility and

Coronary Heart Disease (CHD) Any illness that causes a narrowing of the coronary arteries

Type A Personality Individuals who are hard-driving, competitive, hostile, time urgent, and demanding of both themselves and others, as described by Friedman and Rosenman in their study of coronary heart disease

Type B Personality Individuals who are relaxed, easygoing, not driven to achieve perfection, happy in their jobs, understanding, and not easily angered, as described by Friedman and Rosenman in their study of coronary heart disease

Hypertension Commonly referred to as high blood pressure: A condition of excessive blood flow through the vessels that can result in both hardening and general deterioration of the walls of the vessels

Type D Personality A personality type characterized by negativity, distress, and an inability to share emotions with others (type D personality is a predictor of mortality in patients with cardiovascular disease or cancer)

time urgency, may be as important risk factors as smoking and hypertension for CHD (Bunker, et al., 2003; Welin, Lappas, & Wilhelmsen, 2000).

Hypertension

Hypertension, commonly referred to as high blood pressure, occurs when blood flow through the vessels is excessive, a condition that may cause both hardening and general deterioration of tissue in the vessel walls. It has been estimated that roughly 73 million Americans suffer from hypertension and of that, about 57,000 die annually as a direct result of this condition (American Heart Association, 2012).

A number of physical factors may contribute to hypertension, including such things as obesity and genetic predispositions. However, there is also substantial evidence linking stress and Type A personality factors to hypertension. In fact, a recent study involving 3,142 subjects over fifteen years revealed that subjects who scored high on the time urgency and impatience (TUI), both subscales for Type A personality, were twice as likely to have high blood pressure than those scoring lower. The TUI component of Type A is characterized by a persistent preoccupation with time and pronounced impatience. If you find yourself annoyed following slower traffic or while standing in long lines you may also be at greater risk for developing hypertension (Yan, et al., 2003).

Since Freidman and Rosenman's description of Type A personality, other researchers have focused more carefully on which aspects of personality may actually predict coronary disease outcomes. As a result, the coronary-prone personality was further refined as Type D personality (Denollet, 2005). **Type D personality** is characterized by distress, negative emotions, and an inability to share emotions with others. The 'D' in Type D personality refers to distressed. Research on Type D personality reveals that it is associated with higher mortality in patients with cardiovascular disease and cancer (Martin, Doster, Critelli, Purdum, & Powers, 2011; Mols, Oerlemans, Denollet, Roukema, & Van-de Poll-Franse, 2012). While it is still difficult to predict which individuals will get and survive cardiovascular disease or cancer, we are getting closer to describing how personality interacts with disease processes and outcomes.

(Shutterstock)

A number of physical factors, including obesity and genetics, may contribute to hypertension.

Some people are genetically predisposed toward hypertension, and they may be more reactive to stress than those not genetically predisposed. Reactive people show a more pronounced blood pressure response to a range of stressors (such as exposure to cold water, public speaking, or participation in a challenging cognitive task) than do people without hypertension. It appears that reactive individuals display variants in genes coding for angiotensin receptors (Romano-Spica, et al., 2003). Angiotensin is an important hormone involved in regulating fluid balance, and it is a primary target for drugs used to control hypertension.

Infectious Diseases

Infectious Diseases are diseases caused by microorganisms such as bacteria and viruses. The most common of these diseases are common colds and influenza, but it also includes diseases such as AIDS. Researchers have confirmed a strong correlation between stress and the onset and severity of infectious diseases. (One you may well know as the increase in the number of colds on campus associated with final exams.) The link between these diseases may, however, be more than a correlation. Evidence suggests that stress responses actually impair the ability of your immune system to fight off infections (Cohen & Williamson, 1991; Moynihan, 2003; Tausk, Elenkov, & Moynihan, 2008). Recent research even suggests that exposure to stressful events early in life may actually predispose individuals to disease by compromising how the immune system responds to an infection. This may in part explain why some individuals are more prone to infection throughout their lives than others (Avistur, Hunzeker, & Sheridan, 2006).

Cancer

Evidence linking stress to cancer is certainly more controversial than that for CHD or hypertension. However, many specialists in the fields of oncology and behavioral medicine strongly suspect a connection. **Cancer** is a collection of many diseases, all of which result from genetic alterations in cells that produce runaway cell growth. Although researchers do not completely understand all the mechanisms and agents involved in cancer, compelling evidence suggests a relationship between stress and cancer (Moynihan, 2003; Tausk, Elenkov, & Moynihan, 2008). It has been estimated that 90 to 95 percent of all cancer cases can be attributed to environmental and lifestyle factors including stress. The remaining 5 to 10 percent may be due to genetic defects (Anand, et al., 2008). This suggests that cancer may be more preventable than previously believed and that its prevention will depend on major lifestyle changes.

Animal studies provide information not available in human research. For example, rats that are inoculated with cancerous cells and then exposed to inescapable electric shocks are less able to reject the cancerous cells than are rats that are subjected to escapable shocks (Visintainer, Selligman, & Volpicelli, 1983). This research suggests that the greater stress associated with an uncontrollable event may have reduced the animals' resistance to cancer. Other studies, in which animals have been exposed to stressors such as cold-water immersion, have also reported higher incidences of malignancies than among non-stressed animals (Ben-Eliyahu, Yirmiya, Liebeskind, & Taylor, 1991).

Researchers have also investigated the biological mechanisms linking stress to cancer, and they have implicated that specific stress hormones weaken the immune system (Lamkin, Sloan, Patel, Chiang, & Pimentel, 2012). As we will see, the immune system guards against invaders and foreign tissue of all kinds, including cancerous cells. In fact, the immune system may produce tumor-specific chemicals that attack and destroy cancerous growth. Since we know that prolonged or severe stress can suppress immune response, it follows that stress may also allow cancer cells to proliferate more rapidly than might otherwise occur. In the past few years we have witnessed a rapid expansion in research related to how psychological factors contribute to disease. The new field of **psychoneuro-immunology** and the establishment of new scientific journals, such as *Brain, Behavior, and Immunity,* are evidence that the medical community now takes seriously the influence of emotional states on disease processes.

Cancer A collection of many diseases, all of which result from genetic alterations in cells that produce runaway cell growth

Psychoneuro-immunology The scientific study of the relationships between behavior and disease processes

Stress and the Immune System

Immune System A complex surveillance system that guards the body by recognizing and removing bacteria, cancer cells, and other hazardous foreign substances

The **immune system** is an exceedingly complex surveillance system that guards the body by recognizing and removing bacteria, viruses, cancer cells, and other hazardous foreign substances. When such substances are detected, our immune systems respond by stimulating lymphocytes (white blood cells) to attack and destroy these invaders. The actions of the *lymphocytes,* as well as other immune-system responses, are delicately regulated in an extremely complex process. If the immune system is suppressed, we become more vulnerable to a variety of infectious organisms and cancers. Conversely, a breakdown in the body's homeostasis may cause the immune system to become overactive, turning on itself to attack and destroy healthy body tissues. (This phenomenon occurs in autoimmune disorders such as rheumatoid arthritis.) While diet, age, heredity, and general health all affect the functioning of the immune system, stress also exerts a marked influence on *immunocompetence,* the immune system's ability to defend our bodies successfully (Moynihan, 2003; Tausk, Elenkov, & Moynihan, 2008).

For instance, many studies of nonhuman animals have demonstrated that experimentally manipulated stressors—such as separation from mother, isolation from peers, exposure to loud noise, and electric shock—can reduce immunocompetence by suppressing the activity of the lymphocytes. Research with human subjects has revealed similar results. High-stress periods such as final exam week have also been linked to reduced immunocompetence—a finding which helps explain why people may be more likely to become ill during finals (Jemmott, Borysenko, Borysenko, & McClelland, 1983). Research on adult subjects has also linked symptoms of a variety of infectious diseases, including colds, influenza, herpes, and mononucleosis, to stressful events (Cohen & Williamson, 1991; Jemmott & Locke, 1984).

In summary, there is considerable evidence linking stress with depressed immune function and the onset and progression of both infectious diseases and cancer. Studies with animals have demonstrated strong relationships between the stress of shock, isolation, and loud noise and the ability of the immune system to fight off infectious diseases as well as cancerous tumors. Interpreting data from humans is more difficult because of the difficulty in controlling for the amount and type of stress, but consistent with animal studies. Evidence suggests that the suppression in immune function that follows severe stress is mediated by the release of stress hormones and that stress can have lifelong consequences on the health of your immune system (Avistur, Hunzeker, & Sheridan, 2006; Tausk, Elenkov, & Moynihan, 2008).

CHAPTER REVIEW

The Components of Emotions

1. Motivation and emotion are closely connected. Emotions often motivate our actions.
2. Emotions are composed of four integral components: Cognitive processes, affect, physiological arousal, and behavioral reactions.

The Range of Human Emotion

3. According to Plutchik's Emotion Wheel there are eight primary human emotions, which consist of four pairs of opposites: Acceptance and disgust, fear and anger, surprise and anticipation, and sadness and joy.

Theories of Emotion

4. According to the James-Lange theory, environmental stimuli trigger physiological responses from the viscera and muscle movements. These visceral and muscular responses then activate emotional states.
5. Recent evidence has demonstrated that different emotions are associated with similar, but not identical, physiological changes. Support for the James-Lange Theory is reemerging in recent years.
6. The Cannon-Bard theory suggests that internal physiological changes and muscular responses are not the cause of emotion but rather that emotional experiences and physical changes occur simultaneously.
7. The Schachter-Singer theory combines elements from both the James-Lange and Cannon-Bard theories. Schachter and Singer maintained that emotions depend on a kind of double cognitive interpretation: We appraise the emotion-causing event while also evaluating what is happening physiologically with our bodies.
8. New evidence from the muscle-paralyzing cosmetic drug Botox supports the decades-old theory about the role of facial feedback in emotional experience.
9. Solomon and Corbit's opponent-process theory maintains that when a strong emotional response to a particular stimulus event disrupts emotional balance, an opponent-process is eventually activated to restore equilibrium in one's emotional state. Repeated exposures to stimuli that arouse intense emotions result in a gradual weakening of the initial emotional reaction as the opponent process becomes stronger.

Stress

10. There is a powerful relationship between emotion and stress. Stress may be defined as the process of appraising events (as harmful, threatening, or challenging), of assessing potential responses, and of responding to those events.

11. Selye's observation of organisms' physiological responses to stress led him to formulate the concept of a general adaptation syndrome (GAS) composed of three phases: Alarm, resistance, and exhaustion. A flood of stress hormones that prepare the body for fight or flight characterizes the alarm phase. In the resistance stage the body returns to a less aroused state, but one in which it continues to draw upon resources at an above-normal rate. If the stress is not alleviated, an organism is likely to enter the third state of exhaustion in which its body tissues begin to show signs of wear and tear and susceptibility to disease increases.

12. Factors that contribute to the stressfulness of a situation include our lack of control over it, its sudden onset, and a degree of ambiguity that forces us to spend resource-depleting energy trying to figure out the nature of the stressor.

13. Response to stress may be a major contributor to coronary heart disease.

14. Type A people, particularly those who display anger and hostility, are more prone to CHD than Type B people, who are more relaxed, easygoing, and not driven to achieve perfection.

15. People who deal with anger by suppressing it and those who exhibit Type A behavior may be particularly predisposed to develop hypertension.

16. Type D personality is characterized by distress, negative emotions, and an inability to share emotions with others.

17. Individuals with Type D personality are less likely to survive cardiovascular disease and cancer.

18. Stress hormones exert a pronounced effect on the immune system's ability to defend our bodies successfully against disease.

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POP QUIZ

True or False

___1. According to Plutchik's emotion wheel, there are only eight human emotions.

___2. Schachter and Singer's theory of emotion agrees with the James-Lange theory in that emotions follow physiological and behavioral changes.

___3. Psychological responses to stress include cognitive, emotional, and behavioral responses.

___4. Situations that an individual does not have control over and are sudden and ambiguous are likely to be perceived as stressful.

___5. Stressful events decrease the functioning of the body's immune system.

Multiple Choice

6. The physiological component of emotion is closely associated with which of the following?
   a. Autonomic nervous system
   b. Central nervous system
   c. Skeletal or somatic nervous system
   d. Brain stem functions
7. According to Plutchik's emotion wheel, emotions that are directly across from each other ______.
   a. Are opponent processes
   b. Have the most in common
   c. Are opposites
   d. Are secondary emotions
8. The James-Lange theory is supported by evidence that indicates which of the following?
   a. The hypothalamus is involved in emotional expression.
   b. Feelings of emotions are a consequence of physiological changes caused by emotional stimuli.
   c. Following a fear response, people experience elation.
   d. Individuals tend to look for an appropriate emotional label for physiological changes.

9. The facial feedback theory of emotion is partially supported by the observation that indicates which of the following?
   a. Emotions are always accompanied by changes in facial expression.
   b. Drugs that paralyze facial muscles (eg., Botox) decrease the intensity of experienced emotions.
   c. We often experience the same emotion another is expressing.
   d. Forcing a smile can make people happy even when they are not.
10. Solomon and Corbit's opponent-process theory proposes that with repeated exposure to a situation that produces an intense emotion, the initial emotional reaction will ________ while the opponent emotional reaction will ________.
   a. Weaken / remain constant
   b. Remain constant / grow stronger
   c. Weaken / grow stronger
   d. Grow stronger / weaken
11. Which of the following is ***not*** a common cognitive response to a stressful situation?
   a. Disruptive thoughts
   b. Higher than normal levels of distraction
   c. Feelings of anxiety
   d. Impaired performance on cognitive tasks
12. Which of the following events should be least stressful?
   a. Having your parents tell you they are divorcing
   b. Having your roommate tell you to move out
   c. Having your partner initiate the break up of a long-term relationship
   d. Initiating the break up of a long-term relationship
13. What is the main reason why ambiguous situations may cause stress?
   a. One may not be able to determine an appropriate course of action.
   b. One needs time to mobilize a defense.
   c. One may feel out of control.
   d. One may not be able to plan ahead.
14. The evidence linking stress to ________ is less conclusive and more controversial than for the other illnesses listed.
   a. Malfunctioning of the immune system
   b. Coronary heart disease
   c. Cancer
   d. Hypertension
15. Stress affects the immune system by which of the following?
   a. Reducing immunocompetence
   c. Activating the immune system
   b. Enhancing immunocompetence
   d. Destroying the immune system

Answer Key: 1.F 2.T 3.T 4.T 5.T 6.a 7.c 8.b 9.b 10.c 11.c 12.d 13.a 14.c 15.a