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What Is an Emotion?

THE ROLE OF SOMATOVISCERAL AFFERENCE, WITH SPECIAL EMPHASIS ON SOMATOVISCERAL "ILLUSIONS"

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More than a century has passed since William James (1884) published his influential article titled "What Is an Emotion?" James's provocative answer to this question was that emotional feelings were consequences rather than antecedents of peripheral physiological changes brought about by some stimulus:

AUTHORS' NOTE: Preparation of this manuscript was supported by National Science Foundation Grant No. BNS-8940915 to JTC, National Science Foundation Grant No. BNS-8820027 to GGB, and a National Science Foundation Fellowship to DJK. Address correspondence concerning this manuscript to John T. Cacioppo, Department of Psychology, The Ohio State University, 1885 Neil Avenue, Columbus, OH 43210-1222 (E-mail: Cacioppo.1@osu.edu).

Our natural way of thinking about these standard emotions is that the mental perception of some fact excites the mental affection called the emotion, and that this latter state of mind gives rise to the bodily expression. My thesis on the contrary is that *the bodily changes follow directly the PERCEPTION of the exciting fact, and that our feeling of the same changes as they occur IS the emotion.* (James, 1884, p. 190)

James's theory has stimulated debate (e.g., Baldwin, 1894; James, 1894; Levenson, 1992; Zajonc & McIntosh, 1992) and research (e.g., Ax, 1953; Cannon, 1927; Ekman, Levenson, & Friesen, 1983; Marañón, 1924; Schachter & Singer, 1962; Stemmler, 1989) for more than a century. Research on the influence of cognitive appraisals in emotion (e.g., Smith & Ellsworth, 1987; Valins, 1966; see, also, Smith & Pope, this volume) and on emotions in the spinal cord injured (e.g., Chwalisz, Diener, & Gallagher, 1988) suggests that afferent information from peripheral activity is not a *necessary* condition for emotional experience. James (1884), however, viewed emotions as being multiply determined. For instance, individuals might recall earlier emotional episodes, including their feelings, and, in so doing, they might reexperience the emotion. If the remembered emotion was weak originally (e.g., it involved little or no somatovisceral activation), reexperiencing the emotion might occur in the absence of significant peripheral bodily disturbances. James (1884) therefore stated at the outset that "the only emotions I propose expressly to consider here are those that have a distinct bodily expression" (p. 189), a limiting condition of which James reminded his critics a decade later (James, 1894). James maintained that, within this broad class of emotional phenomena, discrete emotional experiences could be identified with unique patterns of bodily changes, and that the perception of one of these specific patterns of peripheral physiological changes *was* the emotional experience.

Numerous theories of emotion have been proposed since James (1884), but those dealing with the same class of phenomena (i.e., emotions accompanied by significant peripheral physiological changes) are bracketed by (a) models that hold that discrete emotional experiences stem from distinct somatovisceral patterns (e.g., Ekman, in press; Ekman et al., 1983; Levenson, Ekman, & Friesen, 1990) and (b) models that hold that discrete emotional experiences derive from cognitive appraisals that were initiated by the perception of undifferentiated physiological arousal (e.g., Mandler, 1975; Schachter & Singer, 1962).¹

Our goal in this chapter is to begin to sketch an alternative answer to James's (1884) classic question—what is an emotion?—that falls between these brackets.² We do not maintain that the mechanism we describe in this chapter is the only, or even the predominant, determinant of specific emotional percepts; that is for future research to determine. We end by outlining a broad framework within which to view the role of reafference in emotions accompanied by significant somatovisceral changes.

THE PERCEPTION AND INTERPRETATION OF PERIPHERAL BODILY ACTIONS

James (1884) identified three sources of somatovisceral afference that he thought contributed to discrete emotions: the muscles, the skin, and the viscus. Subsequent theorists have differed in the emphasis they have placed on proprioceptive and visceral cues (e.g., Kleck et al., 1976; Laird, 1984; Strack, Martin, & Stepper, 1988; Tomkins, 1962), but Ekman et al. (1983) have recently returned to James's (1884) emphasis on somatovisceral patterning in specific emotional states. Ekman et al. (1983) suggested that previous investigators had failed to isolate specific emotions for a sufficient period of time to allow accurate autonomic assessments, and they used prototypical facial expressions to create or identify epochs during which subjects were experiencing specific emotions (see, also, Levenson et al., 1990). Results indicated that several specific facial configurations of emotions (e.g., happiness, fear, anger) were associated with distinct emotional reports and patterns of visceral responses. These data are compatible with James's (1884) suggestion that there are emotion-specific autonomic patterns of activation. Ekman, Levenson, and their colleagues (Ekman et al., 1983; Levenson, 1992; Levenson, Carstensen, Friesen, & Ekman, 1991; Levenson et al., 1990), like James (1884), have suggested that the distinctive proprioceptive and interoceptive cues associated with basic emotions constitute sensory information, the perception of which can determine emotional experience. Thus this line of theorizing specifies that distinct emotional feelings arise from the perception of discrete and unambiguous sensory information transmitted through the somatovisceral system just as assuredly as distinct visual percepts, such as the image of the old woman depicted in the left panel of Figure 3.1,

arise from physically discrete sensory information transmitted through the visual system.

Although the research on the autonomic differentiation of emotions by Levenson, Ekman, and their colleagues is interesting, the cumulative evidence for emotion-specific autonomic patterns remains inconsistent (e.g., see Lang, Bradley, & Cuthbert, 1990; Stemmler, 1989; Wagner, 1989). Zajonc and McIntosh (1992) further note that the evidence for the autonomic differentiation of happiness, sadness, anger, fear, disgust, and surprise is inconsistent even when one focuses exclusively on the research reported by Ekman, Levenson, and their colleagues over the past decade using what they suggested were methodologically superior procedures. Heart rate appears to be the best discriminator of these emotions, with anger, fear, and sadness sharing comparable elevations in heart rate with respect to the other emotions. Zajonc and McIntosh note, however, that even heart rate is far from discriminating consistently or fully among the emotions in these studies. For instance, Ekman et al. (1983) found heart rate did not discriminate between the emotions in emotional imagery conditions, and it differentiated only anger, fear, and sadness from happiness, disgust, and surprise in a conceptual replication using facial-muscle manipulation to induce discrete emotions. Furthermore, contrary to the findings of Levenson, Ekman, and their colleagues, heart rate was one of the four physiological measures that differentiated anger from fear in Ax's (1953) classic study in which he used realistic and intense manipulations of anger and fear.

Of course, all of the potential elements and patterns of autonomic activity have yet to be studied. Moreover, potential patterns may not be describable by gross measures of end-organ response (e.g., heart rate; see Berntson, Cacioppo, & Quigley, 1991). Thus emotion-specific autonomic changes may indeed exist and may yet be identified. Nevertheless, whether or not the conditions for and the elements of emotion-specific autonomic patterns of activity can be identified, it appears that discrete emotional percepts can occur even when the autonomic changes do not discriminate fully the emotions that are experienced. Is it possible for discrete emotional percepts to be sculpted from an ambiguous or undifferentiated pattern of afference?³ If so, how is this transformation from ambiguous visceral input to unequivocal emotional percept accomplished? Cannon's (1927) answer to the first question was no; autonomic events were too slow, too insensitive, and too undifferentiated to contribute to emotions. Schachter and Singer (1962) revolution-

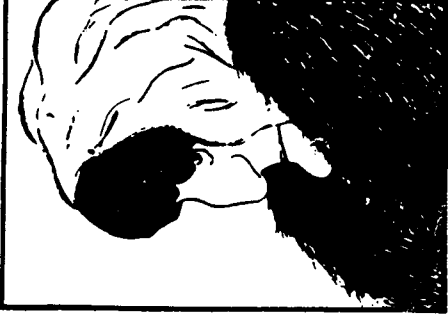


Figure 3.1. An Old Woman
SOURCE: Adapted from Boring (1930).

ized thinking about emotions when they suggested that undifferentiated autonomic activity *could* subserve discrete emotions. The mechanism by which this was accomplished, according to Schachter and Singer (1962; Schachter, 1964; see, also, Mandler, 1975; Reisenzein, 1983), was as follows: Given a state of physiological arousal for which an individual has no immediate explanation, an "evaluative need" is created that motivates the individual to understand and label cognitively his or her bodily feelings. The consequent attributional process was thought to produce specific emotional states and influence emotional behavior.⁴

In sum, emotion theorists such as James (1884) and Ekman et al. (1983) have suggested that the sensory information is unambiguous, and the consequent perception of this sensory input yields a spontaneous and discrete emotional experience. Emotion theorists such as Schachter and Singer (1962) and Mandler (1975), on the other hand, have emphasized the ambiguity in the interoceptive information associated with discrete emotional percepts. The primary roles this interoceptive information plays in emotion, according to their perspective, are to motivate the individual to search for a label for the perceived but unexplained physiological state and to establish the intensity of the labeled emotional state. We propose in this chapter that there is yet a third distinct way in which peripheral bodily reactions may contribute to emotional

experience, an active perceptual process by which an ambiguous pattern of somatovisceral afference is disambiguated to produce an immediate, spontaneous, and indubitable emotional percept. We turn next to the mechanism by which transformations of this form occur.

AMBIGUOUS FIGURES AND SOMATOVISCERAL "ILLUSIONS"

James's (1884) theory of emotion can be viewed as a perceptual theory about the mental consequence of a particular kind or pattern of somatovisceral afference. Theory and research on other sensory systems (e.g., vision) may therefore provide useful insights into the psychological mechanism underlying emotional percepts that are derived from somatovisceral information. For instance, in addition to the class of perceptual phenomena illustrated by unambiguous images (e.g., see the old woman in the left panel of Figure 3.1 and the young woman in the left panel of Figure 3.2), there is a second, interesting class of perceptual phenomena illustrated in the right panels of figures 3.1 and 3.2. These pictures are adaptations of a classic example of an ambiguous visual figure originally published in *Puck* by W. E. Hill (1915) as "My Wife and My Mother-in-Law" and introduced to psychology by Boring (1930). Naive subjects who look at Figure 3.1 or Figure 3.2 report seeing strikingly different images (e.g., Leeper, 1935). Subjects who are exposed to Figure 3.1 report seeing two pictures of the same old woman, whereas subjects who are exposed to Figure 3.2 report seeing two pictures of the same young woman. Moreover, the perceptual experience created by viewing the pair of pictures within Figure 3.1 or within Figure 3.2 is that the pictures are virtually identical, and the picture depicted in the right panel of Figure 3.1 is perceived to be quite different from the picture depicted in the right panel of Figure 3.2. These strikingly different perceptions are immediate, effortless, self-evident, and discrete. Naive subjects do not perceive any of the pictures to be ambiguous. This, of course, is something of an "illusion," because the pictures depicted in the right panels of figures 3.1 and 3.2 are identical. Ambiguous visual figures therefore illustrate how the visual system can be presented with physically invariant stimulus (e.g., contour) information that can be perceived in strikingly different ways.

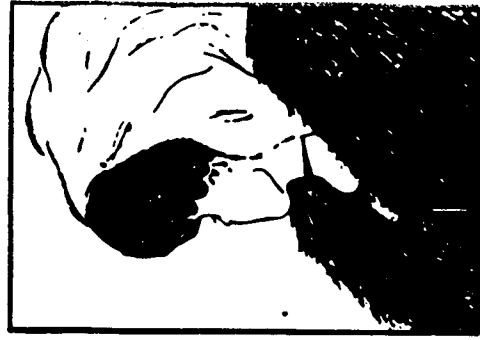
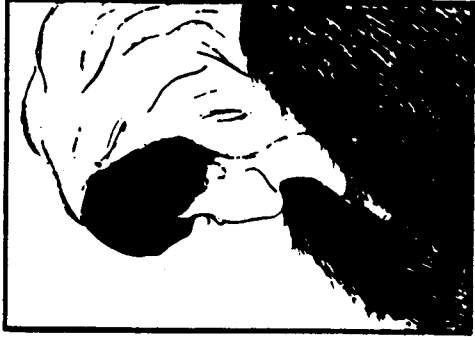


Figure 3.2. A Young Woman
SOURCE: Adapted from Boring (1930).

Although what one sees when looking at an ambiguous visual figure appears to be the work of neural events in the brain beyond the visual cortex (i.e., top-down processes; Sekuler & Blake, 1985), the sensory information provided by the ambiguous figure clearly contributes to this perception. For instance, Leeper (1935) compared the effects of verbal and perceptual preparation on the perception of Boring's ambiguous figure. Verbal preparation involved giving a detailed description of one of the possible organizations—the old or young woman—including the direction the person would be facing, how the person was dressed, and prominent features of the person. Perceptual preparation involved showing the subjects one of the two figures depicted in the left panels of figures 3.1 and 3.2. Leeper found that subjects who had been given verbal preparation did not differ significantly from a control group who received no preparation: Approximately 65% of the subjects reported seeing only the young woman and approximately 35% reported seeing only the old woman. As noted above, however, perceptual preparation had dramatic effects on what subjects perceived when they looked at the ambiguous figure: All of the subjects who first looked at the unambiguous figure of the young woman saw only the young woman

when they looked at Boring's ambiguous figure, whereas 97% (i.e., all but one) of the subjects who first looked at the unambiguous figure of the old woman saw only the old woman when they looked at the ambiguous figure. Thus prior exposure to the young or old woman primed the form of the discrete and unambiguous image such that the perception of the subsequently presented ambiguous figure was perceived to be a discrete and unambiguous image.

Subsequent research suggests that verbal instructions regarding what viewers should look at in ambiguous figures are sufficient to influence what they see, but the nature of the instructions are important. For instance, global instructions such as those used by Leeper (1935) are less effective than specific instructions about what focal area contains features that are significant for the perception of one image but not the other (Tsal & Kolbert, 1985). Moreover, once both unambiguous pictures have been identified or primed, it is possible to switch back and forth between the two images in the ambiguous figure by attending to a focal area that contains features significant for one percept but not for the other (Tsal & Kolbert, 1985). It is important that only one unambiguous picture can be perceived at any given moment. You can confirm this for yourself by focusing on the image of the old woman in the right panel of Figure 3.1: The perceptual experience is that the "ambiguous figure" is not ambiguous at all. Looking at the same figure can yield a strikingly different perceptual experience a moment later, as you "switch" between the two images. Note that, when this switch is made, the perceptual experience again is coherent and unambiguous (even though one recognizes the figure must be ambiguous to be capable of producing such strikingly different perceptual experiences). The belief that the picture depicts a young woman and an old woman is derived through direct experience; the belief that the picture is ambiguous is derived through inference.

Ambiguous visual figures are constructed using elements from two (or more) unambiguous images in such a way that the figure created by overlapping or slightly modifying the elements of the unambiguous images can be interpreted in multiple discrete ways (Sekuler & Blake, 1985). Ambiguous figures therefore have sometimes been referred to as figure-figure reversals (Boring, 1930), which differ from other reversible figures in which the figure and ground reverse (e.g., the chalice/profiles image). Despite our reference to ambiguous figures as "illusions," they are not illusions in the strict sense because there is no

distortion of the stimulus features that contradicts reality (Soltis, 1966). The fact that the same sensory information in an ambiguous figure can produce such strikingly different, immediately obvious, and unambiguous perceptions, however, led Leeper (1935) to refer to ambiguous figures as reversible illusions. It is in this sense that we use the term *illusion* in this chapter.

It is important that, although the invariant information in the ambiguous visual figure can produce very different perceptions through the influences of activated cognitive schemata or categories, the phenomenon of reversible illusions depends fundamentally on the afferent information produced by viewing the figure. Chambers and Reisberg (1985), for instance, reported that subjects could not reverse an ambiguous figure in mental imagery even though these subjects were able to draw an ambiguous figure from their mental image and then reverse the figure in their drawing. Thus the afferent information appears not only to be contributory but to be essential for the class of perceptual phenomena illustrated by reversible visual illusions. The ambiguous sensory information, which can give rise to two or more discrete percepts, is transformed by the active process of perception to yield an immediate and unambiguous perceptual experience. In sum, both the activated schema and the sensory data are important in the production of the percept.

Consider the implications if the active perceptual processes underlying reversible visual illusions are not limited to visual information processing but can also operate on interoceptive (e.g., visceral) and proprioceptive (e.g., postural, facial, vocal) input.⁵ The architecture of the somatovisceral apparatus is more likely to yield ambiguous afference than is the visual system (Reed, Harver, & Katkin, 1990), and it seems likely that events as important and commonplace as the emotions have cognitive representations that include somatovisceral attributes. Thus two important features required for the production of somatovisceral illusions are plausibly in place. A unique prediction that follows from the notion of somatovisceral illusions is that discrete emotions can result from the perception of the same somatovisceral input when this input contains somatovisceral attributes of two or more discrete emotions. A second important prediction is that these discrete emotional percepts are "reversible" as different emotional schema are activated. Thus, just as top-down processes make it possible for people looking at Figure 3.3 to alternate quickly between seeing the face of an Egyptian

woman who is located behind a candlestick and the right and left profiles of identical twins looking at one another, they also make it possible for the person on a ride at an amusement park to alternate rapidly between the states of happy excitement and near-panic fear. With practice, the discrete emotional percepts stemming from ambiguous somatovisceral input should be controllable, much like the visual percepts stemming from ambiguous visual figures. Such practice should produce little or no control over emotional percepts, however, when (a) the somatovisceral input is unambiguous rather than ambiguous or (b) there is a dominant emotion category whose activation in the context has been automated by virtue of prior experience.

We know a great deal about the nature of the unambiguous visual arrays that produce visual perceptions, and this makes it possible to construct ambiguous visual figures and to identify the focal areas in which unambiguous visual information is located in ambiguous figures. Unfortunately, we still know very little about the unambiguous visceral afference that underlies specific emotions or whether emotional-specific autonomic profiles even exist. Indeed, empirical research showing that the *same* pattern (at least superficially) of somatovisceral afference can be associated with discrete emotional experiences, and quite different patterns of somatovisceral afference can be associated with the *same* emotional experience, has been taken as evidence that somatovisceral afference has little or no instrumental role in the production of discrete emotions. Thus another important implication of the notion of somatovisceral illusions is that these empirical results are not *necessarily* incompatible with somatovisceral afference playing an instrumental role in the production of discrete emotions. This is because, although the visual information underlies the images seen in ambiguous figures such as those shown in figures 3.1, 3.2, and 3.3, the same visual information can produce discrete visual percepts, and different patterns of visual information can produce the same visual percepts.

In the next section, we outline in more detail two models of emotional percepts as somatovisceral "illusions" based on the work in perception on reversible visual illusions. Both models assume that emotion-specific somatic (e.g., facial) patterning exists. In the first, we also assume that emotion-specific autonomic patterns exist; in the second, we assume that they do not exist. Because the details of the proposed model differ somewhat given these different assumptions, research designed to clarify the presence and nature of emotion-specific autonomic afference is

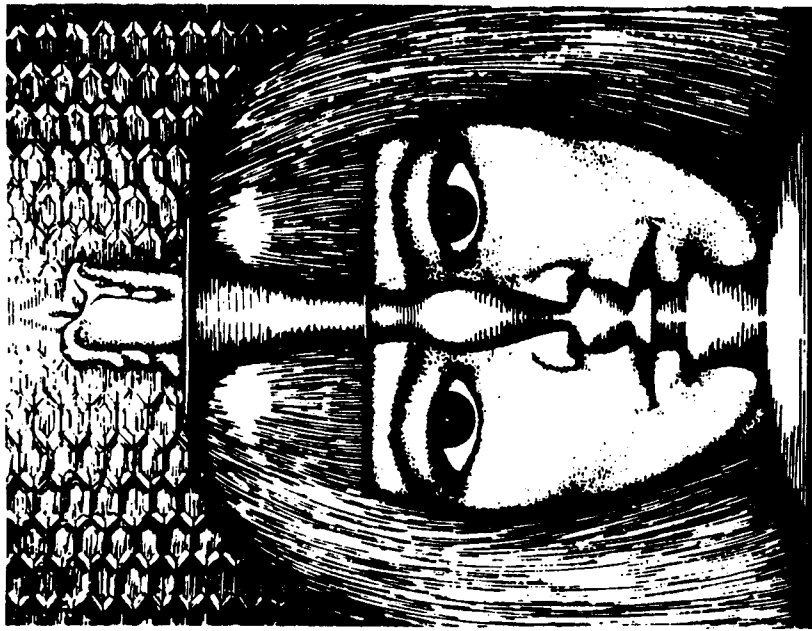


Figure 3.3. An Ambiguous Figure Constructed From Overlapping Unambiguous Elements

SOURCE: From *Mind Sights*, by Roger N. Shepard. Copyright © (1990) by Roger N. Shepard. Reprinted by permission of W. H. Freeman and Company.

NOTE: The picture depicts (a) the face of a woman who is located behind a candlestick and (b) the right and left profiles, respectively, of identical twins looking at one another. These discrete images are derived from the same sensory information and, although one can switch rapidly between these images, one cannot perceive both images simultaneously.

particularly important. We should also note, however, that these two models are not mutually exclusive but can be viewed as complementary. We will return to this point below.

Model 1: Emotional percepts derived from overlapping sets of specific autonomic patterns. To begin, let us assume that at least some discrete emotions can be differentiated autonomically. Ekman et al.

(1983), for instance, reported that the skin temperature of the middle finger of the right hand differentiated anger from fear and sadness, and this result was replicated by Levenson et al. (1990). Skin temperature is not homogeneous, however. Skin temperature can vary across the surface of the body at a given point in time and it can vary at the same site across time. This is precisely the kind of ambiguous sensory input—ambiguous interoceptive information formed by the coincidence of two or more unambiguous patterns of inputs—that enables an activated schema to transform the ambiguous sensory information into one of several possible immediate, discrete, and compelling percepts.

Emotional percepts no doubt involve more than sensations of skin temperature. Studies of people's perception of skin temperature, however, provide evidence that the kind of perceptual transformation that underlies reversible visual illusions also operates on interoceptive input. For instance, Pennebaker and Skelton (1981) asked subjects to track their skin temperature and were told they would be exposed to an "ultrasonic sound." Some subjects were told the ultrasonic sound could cause their skin temperature to increase, and yet others were told that it could cause their skin temperature to decrease, and yet others were told that it could cause their skin temperature to remain constant. Finger temperature was monitored while subjects "listened" to the noise. No noise was actually presented. As expected, measures of finger temperature indicated skin temperature was comparable across conditions and varied across time within conditions. Despite the similarities in the dynamic visceral activity found to occur across conditions, the perceptions of skin temperature varied in a manner consistent with the primed effects of the ultrasonic noise; moreover, just as the discrete visual images that can be seen in the right panels of figures 3.1 and 3.2 correspond to a focusing of attention on particular configurations of stimulus features, the reports of changes in finger temperature by subjects in Pennebaker and Skelton's (1981) experiment corresponded to actual changes in finger temperature. Thus subjects who expected their finger temperature to increase noticed actual increases more than actual decreases in skin temperature, and subjects who expected their finger temperature to decrease noticed actual decreases more than actual increases in skin temperature.

This leaves us with several important but unresolved issues: (a) How are overlapping patterns of emotion-specific afference initiated unless

there is some central determination of what emotion-specific patterns are to be activated in the first place? (b) What governs which emotion schema is activated? These are important and general issues to which we return after discussing the second model of emotion as a special instantiation of reversible illusions.

Model 2: Emotional percepts derived from "undifferentiated" automatic activation in emotion. How can emotional percepts be somatovisceral "illusions" if there are no emotion-specific autonomic patterns, if, instead, all emotions are characterized by myriad catabolic reactions, the intensity and profile of which depend on individual and stimulus response stereotypies, the intensity of the emotion, and the anticipated metabolic requirements of the behavioral response? Schachter (1964) conceded that the particulars of peripheral physiological activation in emotion might differ, but he maintained that the most salient perceptual cue derived from the dynamic interoceptive inputs was arousal. Consistent with this reasoning, research on the accuracy of detecting specific peripheral changes such as heart rate (e.g., Blascovich & Katkin, 1983; Brener & Jones, 1974; Pennebaker, 1982), gastric activity (e.g., Adam, 1978; Whitehead & Drescher, 1980), and finger pulse volume (Pennebaker, Gonder-Frederick, Stewart, Elfman, & Skelton, 1982) has revealed that naive subjects perform at or near chance levels (but see Pennebaker & Skelton, 1981; Skelton & Pennebaker, 1990). Zillmann (1984) has suggested that circulating catecholamines are increased during activity or emotion and that the amount of circulating catecholamines varies with the intensity of the activity or emotion. Zillmann (1983, 1984) reviews evidence that emotional feelings as different as lust and anger can be reversed by allowing the previously activated schema to decay and by activating the alternative emotion schema.

Of course, the fact that people perform poorly when trying to identify a specific peripheral change that occurs in isolation does not mean that the perception of a complex of visceral changes cannot be sculpted by an activated schema for a particular emotion. For instance, intense physiological variations, as might occur in intense emotions, are much better perceived than are moderate physiological changes (Jones & Hollandsworth, 1981; see Reed et al., 1990). Moreover, we do not mean to suggest that the deliberate, accurate perception of specific variations in somatovisceral activity constitutes the emotion any more than the accurate perception of the contours in an ambiguous figure constitutes

the perception of the visual pictures. Top-down processes transform these sensory components to produce an immediate, holistic perception.

It is interesting that recent studies of the peripheral changes people report to have experienced during emotional states have revealed consistent, emotion-specific, and cross-culturally shared patterns of somatovisceral cues (e.g., Nieuwenhuysse, Offenbergh, & Frijda, 1987; Pennebaker, 1982; Rime, Philippot, & Cisamolo, 1990; Scherer, Wallbott, & Summerfield, 1986; Shaver, Schwartz, Kirson, & O'Connor, 1987; Shields, 1984; Wallbott & Scherer, 1986). Although these studies have focused on belief systems of emotions, these belief systems may be based in part on somatovisceral components of emotion. Rime et al. (1990), for instance, reported that (a) joy was associated with warm temperature, changes in cardiac activity, muscle relaxation, and breathing changes; (b) anger was characterized by feeling hot, changes in cardiac activity, muscle tension, and breathing changes; (c) fear was associated with perspiration, changes in cardiac activity, muscle tension, and breathing changes; and (d) sadness was associated with changes in cardiac activity, muscle tension, and a lump in the throat. Rime et al. (1990) considered it "paradoxical that although evidence for actual physiological patterns in emotions is lacking, a very consistent set of data supports the existence of differentiated and reliable patterns based on subjects' self-reports" (p. 39).

A potential resolution to this paradox is that emotional experience, at least under specifiable sensory conditions, is a special instantiation of reversible illusions. Analogous to the distinct images that can arise from looking at the right panels of figures 3.1 and 3.2 or at Figure 3.3, discrete emotions may arise from somatovisceral afference even if there are few or no objective differences in the somatovisceral information traveling to the brain. For this reasoning to be plausible when automatic activity is not emotion specific, we should again be able to identify parallels between the important visual cues in ambiguous visual figures and the somatovisceral cues in emotion. There are at least two lines of empirical research that support this reasoning.

Recall that reversible visual illusions are formed by overlapping (or modifying slightly) the elements from two or more unambiguous visual figures (e.g., compare the left and right panels of figures 3.1 and 3.2). Research on peripheral *somatic* responses has long demonstrated that skeletal muscular actions are faster and more sensitive than are visceral actions (Cacioppo, Petty, & Tassinari, 1989; Leventhal & Mosbach, 1983), and there is now compelling evidence for specific somatic

configurations for at least a subset of human emotions (Duclos et al., 1989; Ekman, 1989; Izard, 1990). Moreover, Ekman (1985, in press) has suggested that the facial actions and expressions identified with a specific emotion are transient, usually lasting no longer than a few seconds, and can be preceded and followed by facial actions and expressions that are identified with other emotions. Given the mercurial nature of proprioceptive cues in emotion, the variability in the proprioceptive cues that can emanate from various points on the body, and the relatively sluggish nature of visceral afferents, proprioception may be an important component of the ambiguous somatovisceral input to the brain.

In addition, recent research in psychobiology indicates that central (brain) states can modulate ascending afferent transmission, which can affect an individual's sensitivity to specific features of a homogeneous reafference pattern. One example is hunger-induced priming of gustatory transmission, which can be seen at the level of the primary central neurons (*nucleus tractus solitarius*) of the gustatory pathway (Scott & Yaxley, 1989). Another example derives from the marked reduction in pain sensitivity and reactivity that can be observed following uncontrollable aversive stimuli (Maier, 1986, 1989). This hypoalgesia appears to be mediated, at least in part, by descending opiate and nonopiate pathways to the spinal cord (Basbaum & Fields, 1984). Both the degree of hypoalgesia, and the relative contributions of opiate and nonopiate systems, have been shown to be dependent on psychological factors, including the predictability and controllability of the aversive event (Maier, 1986, 1989). The effects of these psychological variables appear to be mediated by both associative and nonassociative factors and depend in part on the inherent response dispositions of the subjects to the aversive stimuli (Mimor, Dess, & Overmeir, 1991; see review by Bernston, Boysen, & Cacioppo, in press). Finally, Montoya, Schandry, and Muller (1991) recently found that attentional factors can influence event-related brain potentials to visceral responses. Subjects were identified as being "good" and "poor" at cardiac perception, and event-related brain potentials were time-locked to the R-spike of the cardiac cycle (i.e., the cardioelectrical event corresponding to left ventricular contraction). Analyses revealed that focusing attention on the heartbeat signal had similar effects to focusing attention on external stimuli, and these effects were larger for "good" rather than "poor" heartbeat perceivers.

Returning to the bodily changes people associate with distinct emotions, one finds evidence for considerable overlap in bodily symptoms across emotions.⁶ All four of the emotions examined by Rime et al. (1990), for instance, were believed to be associated with changes in heart rate, and three of the four were believed to be associated with breathing changes and muscle tension. Moreover, most of the symptoms of emotions identified by Rime et al. (1990) are characteristic of sympathetic-adrenal discharge, and bodily responses such as skin temperature and muscle tension show both increases and decreases across the body during sympathetic-adrenal discharge (Johnson & Anderson, 1990). Even when autonomic activity does not differentiate emotions, the details of this activity can be quite complex. General increases in heart rate, for instance, tend to be characterized by beat-by-beat increases and decreases in rate. Such a pattern of autonomic activation is reminiscent of Pennebaker and Skelton's (1981) observations of skin temperature, which was comparable across groups who believed an ultrasonic noise would increase or decrease skin temperature but was variable across time within groups. As we noted above, the groups of subjects in Pennebaker and Skelton's study produced a reliable and differentiated pattern of symptom reports, and these symptom reports were related to actual physiological changes, even though there was no overall difference in the physiological changes among these groups. Activation of a schema for the physiological changes led to very different perceptions of the same sensory input. Thus the visceral afference, even when "undifferentiated" across emotions (see Note 3), may contribute to the construction of an ambiguous somatovisceral figure.

In sum, research on the peripheral bodily changes people associate with discrete emotions has revealed specific syndromes of symptoms across cultures. Several of the elements that constitute these syndromes are common across the discrete emotions and are common to the peripheral physiological changes found during sympathetic-adrenal discharge. Other symptoms, such as thermal sensations, muscle tension, and perspiration, tend to vary across the surface of the body and across time, providing overlapping unambiguous elements that together constitute an ambiguous sensory input. Further specificity can be provided by the proprioceptive cues arising from facial, postural, and vocal actions, which also can change from moment to moment. Thus, in Model 1 and Model 2, the sensory cues available through the somatovisceral affer-

ents share important features with the visual cues in reversible illusions (see Figure 3.3). In theory, all that needs to be added to the somatovisceral afference outlined in Model 1 or 2 to create an immediate, discrete, and vivid emotional percept is an activated emotion schema whose fundamental components are included in the incoming afference. Thus the current conceptualization shares features with both James's (1884) and Schachter and Singer's (1962) formulations but differs from each one in subtle ways, including the constitution of the somatovisceral input, the role ascribed to the activation of emotional schemata prior to the registration of somatovisceral afference, the immediacy and automaticity of the discrete emotional percept that accompanies the registration of the somatovisceral afference, and the reversibility of emotional percepts.

Unresolved Questions

In the preceding sections, we found parallels between the sensory features of a visual reversible illusion and the sensory information available through the somatovisceral afferents in emotion whether we assumed differentiated (Model 1) or undifferentiated (Model 2) autonomic activation in emotion. In this section, we address two important but unresolved issues: (a) How are overlapping patterns of emotion-specific afference initiated unless there is some central determination of what emotion-specific patterns are to be activated in the first place? (b) What governs which emotion schema is activated?

First, if discrete emotional experiences stem in part from active perceptual processes acting on overlapping patterns of emotion-specific information, then a rapid appraisal of the activating event must occur to initiate these overlapping patterns of emotion-specific response. One possible answer to this question holds that activating events (e.g., a gunshot) are evaluated quickly at a rudimentary level to determine their likely appetitive or aversive importance, and that somatovisceral changes capable of supporting a host of appetitive or aversive actions are initiated as a result of this preliminary appraisal. In parallel with this multipurpose somatovisceral activation, more detailed cognitive appraisals of the evocative event can produce somatic actions (e.g., a driver swerving to avoid a head-on collision) and prime-specific emotion categories (see below) prior to or during the central processing of sensations arising from visceral activation. Consistent with this reasoning,

parallel circuits appear to be involved in the evaluation of the potential significance of stimuli. Through classical thalamo-cortical pathways, sensory information may be perceived, and complex (e.g., relational) cognitive appraisals of its emotional significance can be performed. Additional routes, comprising subcortical circuits, appear to be involved in faster, more rudimentary analyses of the emotional significance of stimuli. LeDoux and his colleagues, for instance, have identified a neural pathway from the thalamus to the amygdala, which may support aversive classical conditioning along simple stimulus dimensions even when the primary sensory area in the cortex has been destroyed (e.g., LeDoux, Iwata, Cicchetti, & Reis, 1988; LeDoux, Romanski, & Xagoraris, 1989; see reviews by LeDoux, 1986, 1987). Thus a rapid but crude evaluation of the emotional significance of stimuli may be accomplished within these subcortical circuits. The potential somatovisceral variations stemming from these rapid and crude evaluations may result in precisely the kind of ambiguous sensory input that enables primed cognitive categories to sculpt immediate, compelling, and strikingly distinct percepts.

Another possibility is that ongoing events are evaluated initially at a rudimentary level to determine the likely metabolic demands on the organism, that visceral changes capable of supporting the anticipated metabolic demands are put into motion, and that certain classes of emotions are sculpted from the resulting afference. What distinguishes this from the preceding account is that the autonomic outflow is governed by metabolic rather than emotional demands. Such a mechanism implies either that certain subsets of emotions are tied to distinct levels or types of metabolic demands or that all of the emotions shaped by bodily inputs involve catabolic reactions that are not emotion specific. This mechanism, of course, is much more compatible with the somatovisceral-illusion model based on the assumption of undifferentiated autonomic activity across emotions (see Model 2, above).

If the ambiguous sensory input is to lead to a distinct emotional percept, it is also important for a distinct emotional category to be perceptually primed. Of particular interest is research showing that discrete emotions can be characterized by unique patterns of stimulus appraisal along emotionally relevant dimensions (e.g., Roseman, 1984; Weiner & Graham, 1984). Smith and Ellsworth (1985, 1987; see, also, Smith & Pope, this volume), for instance, found that more than a dozen distinct emotions (e.g., happiness, fear, anger, disgust, contempt, pride,

shame) could be differentiated by appraisals of the situation along six dimensions (i.e., pleasantness, anticipated effort, attentional activity, certainty, human agency, and situational control). Moreover, the activation of discrete emotions did not appear to require appraisals of the situation along all six dimensions. Typical instances of anger were found to be associated with appraisals of uncertainty and high anticipated effort, but the essential dimensions of appraisal for anger appeared to involve only the dimensions of unfairness and other agency. Smith and Ellsworth (1987) make an interesting speculation that emotional blends may result from appraisals along subsets of dimensions:

Thus, if a person appraises a situation to be unfair and caused by someone else, to now be beyond one's control, and to have unpleasant implications for the future, we might expect that person to experience a blend of anger, sadness, and fear. (Smith & Ellsworth, 1987, p. 486)

The blending of emotions has been questioned by Ortony and Turner (1990; Turner & Ortony, in press), but the questions that have been raised leave unresolved how individuals could vacillate among several discrete emotions in close temporal proximity. The current analysis provides such a mechanism. For instance, the images of the old woman and the young woman are not "blended" when a perceiver switches quickly and repeatedly between the two images in Boring's (1930) figure but the person nevertheless experiences these discrete perceptual images nearly simultaneously. An analogous mechanism controlled by an individual's varying cognitive appraisals of the situation may also underlie the complex emotional experiences that Smith and Ellsworth (1987) attributed instead to the workings of an emotional blender.

To illustrate how some emotions may be somatovisceral illusions, imagine that you are driving an automobile along a two-lane highway. An oncoming truck is about to go by when you suddenly see a car that has been following the truck move into your lane in a vain attempt to pass the truck. You swerve reflexively toward the shoulder of the highway to avoid the head-on collision and, as the car and truck pass, you swerve back to avoid hitting an upcoming bridge abutment. Only moments have passed, the road ahead is now clear, and you have not yet had time to think about anything other than steering out of trouble. At a somewhat slower pace, the somatovisceral feedback aroused by the preceding events is making its way into consciousness. These bodily

sensations create such an immediate, intense, and indubitable feeling of fear that you pull off the highway to reflect on what just happened and to gain your composure. Although the fear that flooded over you as the effect of the initial wave of somatovisceral afference made its way to consciousness certainly *seemed* unambiguous, you may have just experienced a somatovisceral "illusion."

How is the somatovisceral "illusion" model of emotion related to other theories of emotion? William James (1884) spoke about emotions as a perceptual consequence of somatovisceral afference in which the somatovisceral activity was unambiguous and unique across emotions—much like the visual information one detects in an unambiguous picture. This latter proposition represents a major distinction between our somatovisceral illusion model of emotion and existing peripheral theories of emotions. James's theory therefore can be viewed as a special case within a broader model of the role of somatovisceral afference in emotion (see below).

In addition, Schachter and Singer's (1962) theory represents a complementing rather than competing perspective on the role of somatovisceral afference in emotion. In the illustration described above on the arousal of fear by a near-head-on collision, there is no evaluative need or misattribution. Moreover, the notion of somatovisceral illusions posit that (a) the somatovisceral input constrains the emotional percepts that are possible (just as the visual arrays in figures 3.1, 3.2, and 3.3 constrain the visual experiences that result from viewing these pictures), and (b) different configurations of the somatovisceral afference are salient in different emotions (just as different visual contours in the right panel of Figure 3.1 are salient if you see an old woman or a young woman). Finally, Schachter and Singer (1962, 1979) neither included somatic (e.g., facial, postural) feedback in their analysis nor emphasized the activation of an emotional schema *prior* to the perception of autonomic activation because one or both of these processes could undermine the arousal of an evaluative need. Thus the current model owes an obvious debt to Schachter and Singer's (1962) seminal theory for pointing to the importance of top-down processes in emotion, but the processes highlighted in the current formulation are not isomorphic with Schachter and Singer's cognitive labeling theory.

Cognitive appraisal theorists have posited that feedback from the periphery is neither necessary nor sufficient for discrete emotions. We agree. But then one can "look" at a mental image of an old woman or a

young woman too. This remarkable feat by the brain does not imply that visual information plays no role in visual images or in reversible visual illusions. Nor do data demonstrating that discrete emotions can be experienced in the absence of somatovisceral afference imply that somatovisceral afference plays no role in emotion (see Chwalisz et al., 1988). For instance, Levenson et al. (1990) reported that, when subjects produced facial configurations that most closely resembled the associated emotional expression, autonomic differences among emotions were most pronounced and self-reports of the associated emotion were most prevalent. We do not maintain that the model we have outlined in this chapter represents the only, or even the predominant, determinant of specific emotional percepts, but that somatovisceral afference can contribute to emotion in ways heretofore not highlighted (e.g., through somatovisceral illusions).

It might also be worthwhile to consider briefly whether the somatovisceral "illusion" model outlined thus far can withstand Cannon's (1927) critique of peripheral theories of emotion. Specifically, Cannon raised five objections to William James's emphasis on interoceptive patterns in emotion.

(1) "*Total separation of the viscera from the central nervous system (CNS) does not alter emotional behavior*" (Cannon, 1927, p. 108, italics in original). Emotional behavior and emotional perception are not equivalent. Demonstration of CNS control over emotional behavior does not preclude the possibility that peripheral events can contribute to emotional perception. Indeed, there is now considerable evidence that suggests peripheral somatic (e.g., Adelman & Zajonc, 1989; Duclos et al., 1989) and autonomic (e.g., Zillmann, 1983) activity contributes to emotional perception and judgment (see, also, Hatfield, Cacioppo, & Rapson, this volume). Thus research on spinal cord-injured humans suggests that, although interoception may not be necessary for emotional experience, it is contributory (Chwalisz et al., 1988).

(2) "*The same visceral changes occur in very different emotional states and in non-emotional states*" (Cannon, 1927, p. 109). We have dealt in some detail with this proposition. Two models were outlined, one based on the presence of emotion-specific visceral patterning and a second based on the absence of emotion-specific autonomic patterning. In either model, somatic activity in emotion adds emotion-specific elements, with the resulting pattern of afference constituting the somatovisceral counterpart to an ambiguous (visual) figure. In addition,

the somatovisceral "illusion" model makes explicit the importance of perceptually primed emotion schema in the experience created by the somatovisceral afference. Although we have emphasized the priming of discrete emotion schema, the perceptual priming of relevant nonemotional schema (e.g., physical exertion) should be capable of sculpting the somatovisceral afference into a discrete nonemotional percept as well.

(3) "*The viscera are relatively insensitive structures*" (Cannon, 1927, p. 111). A key term here is *relatively*, as in relative to somatosensory structures (and the consequent tactile and proprioceptive afference). The somatovisceral afference in the near-crash example described above, however, would not be expected to be subtle. Although in some instances the afference may be subtle, the feature of insensitivity or nonspecificity inherent in the architecture of the viscera is a virtue in the somatovisceral "illusion" model, for it implies that there can be common interoceptive cues that support multiple discrete emotional percepts.

(4) "*Visceral changes are too slow to be a source of emotional feeling*" (Cannon, 1927, p. 112). This feature, too, is a virtue in the somatovisceral "illusion" model for two reasons. First, the faster, more emotion-specific proprioceptive cues can unfold across two or more emotions (thereby contributing multiple overlapping emotion-specific elements to the afference) while the more sluggish visceral reactions contribute ambiguous (and possibly some unambiguous) elements to and a longer temporal integration of the somatovisceral afference. Second, we have implied in this model that the full force of proprioceptive inputs in emotion is felt when the inputs are accompanied by strong autonomic afference and an emotion schema has been perceptually primed. We further suggested that the peripheral events (from which the afference derives) come from a fast but crude evaluation of the emotional significance of the evocative event, whereas the priming of the emotion schema is achieved by a slower but more flexible and relational appraisal of the event. Because the emotion schema must be primed prior to the ambiguous somatovisceral afference reaching the brain for a somatovisceral "illusion" to occur, the sluggishness of the viscera increases the plausibility that somatovisceral "illusions" occur.

(5) "*Artificial induction of the visceral changes typical of strong emotions does not produce them*" (Cannon, 1927, p. 113). As we noted in the preceding points, the priming of an emotion schema is a prerequisite for a somatovisceral "illusion." Thus Cannon's objections to the

role of peripheral physiological responses as determinants of emotion are not problematic for the somatovisceral "illusion" model.

A GENERAL FRAMEWORK FOR THINKING ABOUT THE ROLE OF SOMATOVISCERAL ACTIVITY IN EMOTION

If discrete emotional experiences can stem from mechanisms as different as classical conditioning (e.g., conditioned emotional responses; Miller, 1951; Mower, 1947; Pavlov, 1927), perceptions of specific and unambiguous afference (e.g., facial feedback; emotion-specific ANS feedback; James, 1884), somatovisceral "illusions" (outlined above), cognitive appraisals (e.g., Smith & Ellsworth, 1985, 1987; Smith & Pope, this volume), and attributional labeling (e.g., Schachter & Singer, 1962; see Valins, 1966), what might the moderator variable(s) be? We can only speculate, but at least two variables or dimensions appear important. The first dimension concerns the nature of the somatovisceral afference (i.e., input). Afference is less relevant to cognitive appraisal theories (e.g., Smith & Ellsworth, 1985) and perhaps to theories of conditioned emotional response (see Miller, 1951).⁷ Undifferentiated afference (see Note 3) is most compatible with the attributional labeling theories of Schachter and Singer (1962) and Mandler (1975); ambiguous afference (as in Boring's "ambiguous" figure) predicates our somatovisceral "illusion" model; and unambiguous emotion-specific afference underlies James's theory of emotions. The second dimension concerns the extent of informational analysis or cognitive elaboration to which the stimulus is subjected prior to the emergence of emotional experience. Conditioned emotional responding, for instance, can occur with minimal informational analysis; the cognitive appraisal (and visceral "illusion") models require more cognitive processing; and cognitive labeling theories tend to require the most. Neither dimension alone completely distinguishes among these various theories, but the two dimensions together do.

These considerations yield a general framework within which to view the various mechanisms by which somatovisceral afference influences emotional experience (see Figure 3.4). This Somatovisceral Afference Model of Emotion, or SAME, specifies possible mechanisms by which and conditions under which (a) the *same* pattern of somatovisceral afference

leads to discrete emotional experiences and (b) quite different patterns of somatovisceral afference lead to the *same* emotional experience.

The SAME is designed to explain emotional states that stem from somatovisceral feedback. A stimulus undergoes at least a rudimentary evaluation, which leads to significant changes in somatovisceral activity. These variations can range from emotion-specific patterns of activation to undifferentiated activation, with ambiguous somatovisceral activation (i.e., partially differentiated activation patterns specific to multiple emotions) falling between these two end points along a continuum of somatovisceral patterning (see Figure 3.4, left column). The nodes along this continuum therefore represent important transitions in the constitution of the autonomic response, but the openings between these nodes underscore the continuous nature of this dimension. The pattern of somatovisceral activation produces a parallel continuum of somatovisceral sensory input to the brain. The arrows between nodes denote the major pathways for information flow.

In addition to these peripheral events, the emotional significance of the stimulus and the somatovisceral afference undergo more extensive cognitive evaluation. Thus Figure 3.4 also depicts the cognitive operations performed on the somatovisceral afference required to produce discrete emotional states. The extent of the cognitive elaboration of the somatovisceral afference required to produce an emotional experience ranges from simple informational analyses such as pattern recognition (e.g., James's theory of emotion as the perception of discrete patterns of somatovisceral afference) to much more complex attributional analyses and hypothesis testing (e.g., Schachter and Singer's two-factor theory of emotion), with simple cognitive appraisals of the stimulus and perceptual priming of an emotion schema falling between these two end points (e.g., emotional percepts as somatovisceral "illusions"). The more extensive these cognitive operations, the longer it takes for them to be completed and, consequently, the longer it takes for the somatovisceral afference to affect emotional experience. Thus simple pattern recognition can produce an emotional experience relatively quickly, whereas detailed cognitive appraisals, attributional analyses, and systematic hypothesis testing can take longer.⁸ Note that quite different patterns of somatovisceral afference (see Figure 3.4, left column) can lead to the same emotional experience via three very different psychophysiological mechanisms (see Figure 3.4, right column), whereas the same pattern of somatovisceral afference can lead to discrete emo-

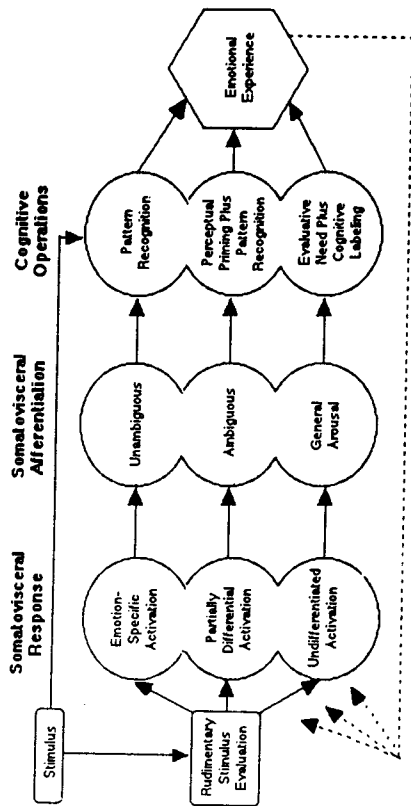


Figure 3.4. The Somatovisceral Afference Model of Emotion (SAME)

NOTE: The same pattern of somatovisceral activity has been associated with surprisingly different emotions, and the same emotion has been associated with quite different patterns of somatovisceral activity. These results have been viewed as evidence against the importance of somatovisceral afference in emotion. The SAME, depicted above and described in the text, encompasses both of these findings while emphasizing the instrumental role of somatovisceral afference and cognitive/perceptual processes in producing each.

tional experiences by two distinct psychophysiological mechanisms: (a) somatovisceral "illusions" when the afference is ambiguous and an emotion schema has been primed and (b) cognitive labeling when the perception of the afference is undifferentiated with respect to an emotion and there is an evaluative need.

Inspection of Figure 3.4 also indicates some of the boundary conditions of these theories. For instance, James's (1884) theory focused on the mechanism outlined in the nodes at the top of the continua, and he did not consider the direct effects of the evaluation of the evocative stimulus on the emotional state. Cannon's (1927) theory of emotion was limited to the direct effects of the evaluation of the evocative stimulus on the rudimentary evaluative processing circuit and on the resulting (but emotionally inconsequential) activation of the viscera. Cognitive labeling theories such as Schachter and Singer's two-factor theory of emotion have focused more on the mechanism represented in the nodes at the bottom of the continua in Figure 3.4, although their emphasis on top-down processes in the interpretation of visceral reactions in emotion predates the current

model. Finally, the somatovisceral "illusion" models discussed above are represented by the middle nodes in these continua.

Of course, the arousal of an emotional state often marks an interruption of an ongoing action and the redirection of biological and cognitive resources toward some stimulus or goal. The resulting efferent volleys can have dramatic effects on somatovisceral variations and patterns (see Figure 3.4, dotted line). An interesting implication of this efferent circuit is that an emotional experience need not begin with an external stimulus. If a frightening external stimulus were presented, the general formulation depicted in Figure 3.4 specifies three separate mechanisms by which somatovisceral activity could contribute to the emotion of fear. In addition, (a) if fear has been perceptually primed (e.g., by having viewed a truly frightening movie; by having observed a frightening medical procedure), this central state can affect perception and emotion in an otherwise innocuous context; (b) vivid mental imagery or remembering an emotional period in one's life can produce somatovisceral changes, afference, and escalations or changes in emotional experience; (c) autonomic variations can be triggered chemically (e.g., Schachter & Singer, 1962) or by exertion, and these autonomic responses feed forward to produce an emotion if and only if the requisite cognitive operations are in place; and (d) central states may be manipulated directly by stimulation or pathology (e.g., "amygdalar rage," psychomotor epilepsy, Dyscontrol Syndrome). Thus the SAME is a closed loop with varying weights assigned to specific paths to emotional experience dependent on factors such as the sensory figure stemming from the somatovisceral activation and the timing and nature of the cognitive/perceptual operations performed on the somatovisceral input.

How might one go about testing the SAME? Creating an ambiguous visceral afferent array from unambiguous visceral components of discrete emotions is precluded given the current state of knowledge about the visceral components of discrete emotion. Research spearheaded by Tomkins (1962), Ekman (1971), and Izard (1971, 1977), however, has provided a clearer set of findings regarding the prototypical facial configurations associated with discrete emotions. Hence it should be possible to construct an ambiguous array of facial feedback by combining catabolic activity with unambiguous portions of the expressions of two different emotions. The successful construction of an ambiguous facial configuration should result in an ambiguous *visual* figure from the perspective of an observer, and an ambiguous array of *facial affer-*

ence from the perspective of the actor. According to the SAME, the emotional consequence of evoking such a somatovisceral configuration is not a blending of the two emotions, rather it specifies a mechanism by which one of the discrete emotions is perceived or both "co-occur" in the sense that the perceptual experience vacillates between the two discrete emotional percepts. Thus, if unambiguous components of the facial expressions associated with disgust and anger were combined to form an ambiguous visual figure, the priming of one or the other emotion schema should foster the arousal of the emotion of disgust or anger.

The SAME also suggests that the immediate emotional percept arising from an evocative event (e.g., the narrow avoidance of a fatal automobile accident; the feelings aroused when one believes one has been treated unjustly) differs quantitatively if not qualitatively when somatovisceral afference is present versus absent. Chwalisz et al. (1988) found that the spinal cord injured experience emotions much like the noninjured, and they interpreted this to mean that somatovisceral afference does not play a major role in emotion. The language people use to describe their feelings, however, can be influenced dramatically by changes in judgmental perspectives (Cacioppo, Andersen, Turnquist, & Tassinari, 1989; Ostrom & Upshaw, 1968), such as in terms of what constitutes an "intense" emotional experience. Thus it may be noteworthy that Chwalisz et al. (1988) interviewed handicapped individuals who were active, nonhospitalized, and had had a long time to adapt to their disabilities. Hohmann (1966), in contrast, asked a sample of outpatients at a Veterans Administration hospital to compare their emotional life at the time of the interview with their experiences prior to their injury. Hohmann (1966) found that the intensity of emotional experiences was reduced proportionally with higher lesions. Although the study by Chwalisz et al. (1988) was methodologically superior to Hohmann's along several dimensions (e.g., psychometric properties of the assessments), Hohmann's procedures were less likely to confound the extent of spinal cord injury with changes in the judgmental perspective. Thus somatovisceral afference may play a more important role in emotion than is implied by the Chwalisz et al. (1988) study.

CONCLUSION

A fundamental assumption of the framework outlined in this chapter is that there are direct parallels between the perception of sensory

information carried through the visual system in reversible illusions and the perception of sensory information carried through the somatovisceral system in emotion. We further propose that these parallels stem from their adaptive significance. The model outlined in Figure 3.4 affords tremendous flexibility and adjustment in the pattern of somatovisceral activation rallied to deal with an environmental challenge while also allowing the operation of powerful and largely automatic inferential principles to transform the somatovisceral afference into a generally adaptive (e.g., organizing) emotional percept. Illustrative of the flexibility highlighted by the SAME are the predictions that the same pattern of somatovisceral activation can lead to discrete emotional experiences, and the same emotion can result from different patterns of somatovisceral activation. The constraints on this flexibility derive from two sources: the priming of an emotion schema and the specificity of the somatovisceral activity that is aroused by the evocative event. These constraints are an important source of adjustment for individuals in a complex world because they are generally adaptive. Thus Shepard's (1990) discussion of the behavioral significance of visual illusions, ambiguities, and anomalies applies equally well to somatovisceral afference:

The illusions, ambiguities, and other visual anomalies that have been explored by artists and by perceptual psychologists are not manifestations of arbitrary quirks, glitches, or design faults of the human visual system. Rather, these perceptual aberrations arise from the operation of powerful and automatic inferential principles that are well tuned to the general properties of the natural world. We owe our very existence to the effectiveness with which these principles have served our ancestors. (p. 212)

It is important that these constraints can also be modified based on the unique contingencies encountered by individuals, thereby contributing further to the adjustment afforded by emotions guided by a mechanism such as that depicted in Figure 3.4. To illustrate, viewing a frightening sequence of events should prime a fear schema and enhance the likelihood that undifferentiated or ambiguous somatovisceral afference would be perceived as fear. Thus a spatiotemporal context in which fearful events are common is likely to be dangerous, and wariness in the face of an ambiguous evocative event in that context is likely to be adaptive. Of course, certain contexts featuring fearful events (e.g.,

movies) are not dangerous, and an individual's learning history can attenuate the emotional priming that would otherwise result from exposures to the fearful events.

Regardless of the ultimate usefulness of the details of the models we have outlined in this chapter, theory and research on perception may have more to contribute to the study of emotion than typically has been recognized. First, many perceptual processes are invariant across sensory modality. Indeed, this fact forms the theoretical foundation for methodologies involving cross-modal matching. The identification and application of these invariant processes to the study of somatovisceral afference and emotion may illuminate mechanisms underlying some aspects of emotional experience.

Second, a number of theories of emotion are in part perceptual theories about the mental consequence of a particular kind or pattern of somatovisceral afference. The precise nature of these patterns of somatovisceral afference is still in dispute, however (e.g., see Turner & Ortony, in press). Therefore it may be informative to use external stimuli acting upon a telereceptive sensory (e.g., visual, auditory) system to model the perceptual implications of the sensory information posited by these theories.

Third, demonstrations that one can "see" strikingly different images even though the sensory input is identical (e.g., see the right panels of figures 3.1 and 3.2 or see Figure 3.3) underscore how invariant sensory information can be sculpted by powerful and automatic inferential principles to produce discrete mental phenomena. Thus we examined the stimulus features and cognitive components underlying a class of perceptual phenomena termed reversible *illusions* to examine how analogous patterns of somatovisceral activity might be sculpted during the active process of perception to form discrete emotional experiences. Related to this, demonstrations that one can "see" the same image even though the sensory input differs (e.g., see the left and right panels of Figure 3.2; see Figure 3.3) underscore how there are multiple means of achieving the same percept—a possibility we have suggested holds for emotional percepts as well. Thus the general framework proposed in Figure 3.4 to organize and stimulate theory and research on the role of somatovisceral afference in emotion takes as a given the very pair of observations that have been interpreted heretofore as evidence against the importance of somatovisceral activity in emotion.

NOTES

1. We do not mean by this that physiological arousal per se is depicted as being undifferentiated in these theories but only that the *perception* of the peripheral physiological activation is general and diffuse. Although not the focus of this chapter, differentiated reafference that does not reach the level of awareness that permits verbal description or cognitive elaboration may nevertheless exert a notable impact on central substrates for emotion. An example is baroreceptor activity, which can modulate afferent transmission and central reactivity. Here we focus on perceptual features.
2. James's (1884) theory focused on the role of the feedback from facial and peripheral bodily responses in what people felt during what were consensually regarded as "emotions" (e.g., fear, anger, sadness, happiness). Interesting theoretical work has addressed the definitional question of what an emotion is (e.g., Bindra, 1969; Ortony & Turner, 1990; Pribram, 1970; Zajonc, Murphy, & Inglehart, 1989), but our focus in this chapter is more limited (e.g., see James, 1884; Schachter & Singer, 1962).
3. There is now considerable evidence that is inconsistent with the notion that autonomic activity increases in a general and diffuse manner during emotion. For instance, reliable individual and situational stereotypes have been documented (e.g., see reviews by Cacioppo et al., 1992; Lang et al., 1990). Moreover, neural changes within the sympathetic nervous system can be highly fractionated (see Johnson & Anderson, 1990), and different patterns of sympathetic and parasympathetic activity can underlie similar-appearing autonomic responses (Bermston Cacioppo & Quigley, 1991). Hence, by "undifferentiated" pattern of autonomic response, we mean only that the autonomic responses (from which interoceptive feedback is derived) do not differentiate specific emotions such as fear and anger.
4. This poses an interesting question on the potential role of reafference in animals, because they are not likely to have been subject to social reinforcement or survival advantage in explicitly defining, describing, or characterizing reafference patterns. On the other hand, the ability to perceive emotional states in others (e.g., by piloerection, pupillodilation, facial configurations) may have been extremely important in survival and may be the evolutionary origin of the disposition to attribute emotional states to others and ultimately to oneself.
5. There are also limitations to the usefulness of the analogy to visual processes. For instance, in the perception of ambiguous visual figures, the stimulus is a visual array outside the body. The central nervous system, however, serves to create and interpret both the stimulus and the response to somatovisceral information. In this regard, visual processes are somewhat more like somatic instrumental processes than visceral processes. Both differ from visceral perception, for instance, in the distinctiveness of the reafference. In the somatic case, the accuracy of response is readily ascertainable, and correctable, by somatosensory and visual feedback. In the visceral domain, there is no "intended" outcome in the conscious sense (although there are target outcomes in an automatic or homeostatic sense). Hence visceral perception differs from somatic and visual perception in that there is no discrete criterion (or "correct" perception) for which an individual is

consciously looking. For this reason, visceral afference may be particularly prone to misperceptions and "illusions."

6. If the emotion schemata are characterized by some distinctive visceral cues, the question arises about the origin of these features in emotion schemata. Several possibilities have been suggested. Rime et al. (1990), for instance, suggested that strongly differentiated patterns of autonomic activity may characterize intense emotions and that people's identification of these peripheral changes as occurring during these emotional states results in these symptoms becoming salient features in the emotion schema. This view is consistent with the cross-cultural stability in emotion schemata found by Rime et al. (1990; see, also, Rime & Giovannini, 1986; Wallbott & Scherer, 1986). Rime et al. (1990), however, favored a social constructivist explanation for the distinctive symptoms in emotion schemata. In this view, people learn what bodily symptoms are supposed to occur in each emotion by descriptive expressions in daily interactions, literary productions, tales, legends, poems, and so forth. A third possibility is that the central organization of emotion includes circuits that, when activated, prime emotion schemata. These schemata would be complete with somatovisceral features and would require only the feedback from the somatovisceral events unleashed to deal with the evocative event to yield a discrete emotional experience of an intensity proportional to the intensity of the somatovisceral feedback. Although future research can be conducted to distinguish among these hypotheses, there is now considerable evidence to suggest that "individuals are endowed with a set of expectations about the peripheral changes to be experienced in various emotional states" (Rime et al., 1990, p. 48). This is the important point here, because the existence of emotion schemata, regardless of their origin, is a prerequisite for the sculpting of discrete emotional perceptions from ambiguous somatovisceral afference.

7. The simultaneous or short forward temporal coupling of discrete conditioned (CS) and unconditioned stimuli (UCS) fosters the development of conditioned responses (CR) that are linked explicitly to the conditioned stimulus. Conditioned emotional responses developed under contingent associations of this type may result in but not rely on somatovisceral input. It is interesting that CS-UCS contingencies characterized by long (e.g., 2 s) temporal lags result in CRs that are more generally associable (Klein & Mowrer, 1989). Conditioned emotional responses therefore are not all alike. Somatovisceral afference is likely to play a more important role in the latter than in the former conditioned emotional responses. Cacioppo, Petty, Losch, and Kim (1986) similarly reasoned that facial feedback may become empowered to influence emotions by virtue of its loose temporal coupling with affective experiences. Thus the proprioception from expressing sadness sporadically when feeling sad could, over time, alter the emotional significance of this proprioceptive feedback. Nevertheless, the close temporal pairing of discrete conditioned and unconditioned stimuli should rely much less on somatovisceral afference in the production of conditioned emotional responses.

8. Feature detection and discriminative processing, of course, also occur during complex cognitive appraisals, but the proximal cognitive operations that combine with the somatovisceral afference to produce the discrete emotional states are what are of interest here.

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Temperamental Contributions to Emotion and Social Behavior

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Jerome Kagan is Professor of Psychology at Harvard University. His research interests focus on continuity and discontinuity in personality development with a special emphasis on the influence of temperament. His most recent books include *The Nature of the Child and Unstable Ideas*.

Although the ideas of temperament, emotion, and behavior share some features, each concept has a distinct meaning. An *acute emotion* is a profile of physiological, cognitive, and motor reactions to a class of incentives but need not involve social behavior. *Social behavior* refers to interactive response profiles that need not involve any acute emotional state. The concept of *temperament* refers to an inherited physiological bias that predisposes a child to particular emotional and behavioral reactions in specific contexts. An illustration of the differences among the three terms is contained in the following example. Most young children react with an acute emotion of mild fear or anxiety and behavioral restraint for several minutes upon encountering a large group of unfamiliar children. This is an almost universal phenomenon. But there is a small group of about 15% of children who react with an extreme degree of fear to a group of unfamiliar children, as well as other unfamiliar events, and will avoid interacting with them for a half hour or more because of an inherited temperamental characteristic.

Until recently, psychologists have been reluctant to award much power to the temperamental factors that contribute to the ease with which certain emotional states are provoked, the intensity of those states, and their associated social behaviors.

This lacuna is due to two relatively independent factors. One is attributable to the Western egalitarian ethic that dislikes the idea that people vary endogenously in their susceptibility to certain emotions. A

AUTHOR'S NOTE: The research reported in this chapter was supported by grants from the John D. and Catherine T. MacArthur Foundation and the Leon Lowenstein Foundation.