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2

The International Affective Picture System (IAPS) in the Study of Emotion and Attention

In this chapter, we discuss the development and use of picture stimuli incorporated in the International Affective Picture System (IAPS, pronounced “eye-aps”; Lang, Bradley, & Cuthbert, 2005), a large set of emotionally evocative color photographs that includes pleasure, arousal, and dominance ratings made by men and women. The IAPS is currently used in experimental investigations of emotion and attention worldwide, providing experimental control in the selection of emotional stimuli, facilitating the comparison of results across different studies, and encouraging replication within and across psychological and neuroscience research laboratories. Numerous studies in our laboratory over the past 15 years have explored subjective, psychophysiological, behavioral, and neurophysiological reactions when viewing these affective stimuli. Basic findings from these studies, which will be informative for researchers considering or using the IAPS stimuli, are briefly summarized in this chapter.

The Problem

If scientists wish to study the effects of background noise on the efficiency of factory workers, it is fairly easy for them to control the type of noise by using accepted physical scales for determining loudness and frequency. Because these established scales are widely used, results can be exactly evaluated by retest (even in another laboratory), confirming or disconfirming the original results. In this systematic manner, science progresses in many of its fields of endeavor.

Unfortunately, researchers in psychology, neuroscience, and psychiatry have, in the past, lacked recourse to similar standards for specifying the emotionality of stimuli. In fact, there are no obvious physical parameters that can be used to organize emotional stimuli. Stimuli that are visually similar, for example, such as a snake and a garden hose, can differ widely in emotional impact across individuals or prompt affect in one context and yet fail to do so in a slightly different setting. One person may fear cats, whereas her neighbor can’t get enough of them. The anticipated beefsteak that makes one diner glow with pleasure disgusts the vegetarian. There is great diversity of emotional reactions to physically equivalent events.

Nonetheless, the emotion researcher needs standards and metrics in order to reach a scientific understanding of the issues fundamental to emotional health—to provide timely information on disturbances in emotional development, to assess the physiological impact of stress, to evaluate emotional psychopathology, to determine the degree of emotional impairment in brain-damaged patients, and to construct more efficient treatments for fear, anxiety, and depression. Historically, investigators have dealt with this problem by developing unique stimuli for study in each emotion experiment. Stimuli used in one laboratory, however, were seldom available to other laboratories. And attempts at recreating the same experimental materials from descriptions in the literature often resulted in stimuli that were quite disparate, rendering replication problematic and undermining the communal effort that is essential to a cumulative science.

In recent years, we have begun to address the seemingly intractable problem of emotional stimulus standardization. To begin this effort, we collected photographs that depict the people, objects, and events that represent human experience. We elected to begin by using pictures as affective stimuli for a number of reasons: their clear evocative ability; the relative ease of editing, cataloguing, and distributing these stimuli; and the fact that pictures are static cues. A static (i.e., unchanging) cue is particularly desirable in the initial investigation of emotion, as other affective cues (e.g., films, stories, etc.) can contain movement, narrative development, or other dynamic changes in the information array that can complicate interpretation of the measured affective response. For instance, a number of psychophysiological measures of emotion (e.g., heart rate, event-related potentials, etc.) are sensitive to dynamic changes in the sensory array, making it more difficult to assess modulation that is specifically due to affect. Controlling these parameters in dynamic stimuli is more complex than with static pictures, whose physical parameters are relatively easy to control—including, for example, image size, duration, brightness, luminosity, color, and so forth. This ease of control is useful for both stimulus selection and experimental manipulation. In this digital age, pictures are also easy to edit and manipulate, as well as to catalogue and distribute, a primary goal when creating the IAPS.

The IAPS (Center for the Study of Emotion and Attention [CSEA], 2004) currently includes more than 1,000 exemplars of human experience—joyful, sad, fearful, angry, threatening, attractive, ugly, dressed and undressed people; houses, art objects, household objects; housing projects; erotic couples; funerals; pollution; dirty toilets; cityscapes, seascapes, landscapes; sports events; photojournalism from wars and disasters; medical treatments, sick patients, mutilated bodies; baby animals, threatening animals, insects; loving families; waterfalls; children playing—a virtual world of pictures. Each picture in the IAPS is rated by a large group of people (both men and women) for the feelings of pleasure and arousal that the picture evokes during viewing. The pictures are then numbered (4 digits) and catalogued according to the mean and standard deviation of these affective ratings and distributed freely to academic researchers. Using these ratings, scientists can select and/or match pictures on the basis of the average reported emotional impact of that picture and are able to control for emotional arousal when investigating effects of hedonic valence and vice versa. Most important, the IAPS encourages replication and extension of published experimental reports using the same or similar stimulus material, promoting a cumulative increase in scientific knowledge.

Evaluative Judgment and the Motivation Organization of Emotion

The IAPS stimuli are standardized on the basis of ratings of pleasure and arousal. This decision reflects both theory and data. In the nineteenth century, Wundt (1896) first proposed a dimensional model of affect as part of his ideas concerning mental chemistry, arguing that affect resulted from variations in basic dimensions of pleasure and arousal. Later, based on factor analyses of evaluative language, Osgood and coworkers (e.g., Osgood, Suci, & Tannenbaum, 1957; see also Mehrabian & Russell, 1974; Russell, 1980) developed a dimensional theory of semantic meaning after finding that the most variance in semantic judgments was accounted for by a single factor, hedonic valence, which ranged from unpleasant (unhappy, annoyed, despairing, etc.) to pleasant (happy, pleased, hopeful, etc.). The fundamental role of hedonic valence in emotions received further support from studies of language categorization (Ortony, Clore, & Collins, 1988; Shaver, Schwartz, Kirson, & O'Connor, 1987), which proposed that human knowledge about emotions is hierarchically organized with a superordinate division between positivity (pleasant states: love, joy) and negativity (unpleasant states: anger, sadness, fear). A second dimension resulting from Osgood's factor analytic work also accounted for substantial variance in evaluative judgments; this was a dimension he labeled *arousal*. This dimension reflects the activation parameter in affective experience and ranges from an unaroused state (calm, relaxed, sleepy, etc.) to a state of high arousal (excited, stimulated, wide awake, etc.).

We have previously proposed that two motive systems exist in the brain—appetitive and aversive/defensive—that account for the primacy of the hedonic valence and arousal dimensions in emotional expression (Lang, 1995; Lang, Bradley, & Cuthbert, 1990). These neural systems are evolutionarily old, shared across mammalian species, and have evolved to mediate the behaviors that sustain and protect life. The defense system is primarily activated in contexts involving threat, with a basic behavioral repertoire built on withdrawal, escape, and attack. Conversely, the appetitive system is activated in contexts that promote survival, including sustenance, procreation, and nurturance, with a basic behavioral repertoire of ingestion, copulation, and caregiving. These systems are implemented by neural circuits in the brain, presumably with common outputs to structures that mediate the somatic and autonomic physiological systems involved in attention and action (see Davis, 2000; Davis & Lang, 2003; Fanselow, 1994; LeDoux, 1990). Thus motivational activation is associated with widespread cortical, autonomic, and behavioral activity that varies in its intensity. Judgments of hedonic valence indicate which motivational system is engaged; judgments of arousal index the intensity of its activation.

Emotional engagement relies on the activation of neural circuits, subcortical and cortical, that mediate the expressive, autonomic, and somatic changes typically associated with affective expression. Pictures are particularly good cues for this associative activation, as they share sensory features with the actual object—a picture of a snarling dog shares a number of perceptual features with an actual dog (e.g., teeth, eyes, mouth open, etc.), making it more likely that this cue will match and activate visual representations that include associations to the subcortical structures that mediate defensive behavior. Other types of cues, such as language ("the dog growls menacingly"), do not share sensory/perceptual features, making it less likely that these cues will strongly engage the fundamental motivational systems. Particularly for humans, who are highly visual creatures, pictures are able to accurately represent many of the most arousing affective events (e.g., sexual, nurturing, threatening).

According to this motivational view, the diversity of specific expressed emotions (e.g., fear, anger, disgust, etc.) evolved from different *tactical* reactions to a broad context of stimulation. Thus, for example, a rat shocked on its footpads may attack a companion animal (an anger prototype) or, if alone, may become immobile and freeze (a fear prototype). When given an escape path, the rat may flee the field (fear prototypes). The *contextual tactics* of approaching or withdrawing have become much more varied in humans. Nevertheless, the *strategic frame* of appetite and defense remains fundamental in emotional experience (Lang et al., 1990). Thus, although the tactical demands of the specific context may variously shape affective expression, all emotions are organized around a motivational base. In this sense, pleasure (appetite or defense) and arousal (motive intensity) can be considered to be the strategic dimensions of the emotion world.

SAM Ratings of Pleasure and Arousal

To measure the pleasure and arousal of IAPS stimuli, we use a rating instrument called the *self-assessment manikin* (SAM; Lang, 1980). As Figure 2.1 illustrates, SAM is a graphic figure that ranges from smiling and happy to frowning and unhappy in representing the hedonic valence dimension. For the arousal dimension, SAM ranges from excited and wide eyed to relaxed and sleepy. Participants indicate feeling *neither* happy nor unhappy (i.e., neutral), or neither calm nor aroused, using the midpoint of each scale. In this version of SAM, the participant can fill in any of the five figures depicting each scale or the box between any two figures, resulting in a 9-point rating scale for each dimension. (In addition to the paper-and-pencil version, a 20-point SAM scale exists as a dynamic computer display on a variety of different systems [Cook, Atkinson, & Lang, 1987] that is highly correlated with ratings on the 9-point SAM scale.)

To determine whether SAM ratings are comparable to the factor analytic scores of pleasure and arousal derived from the relatively longer semantic differential scale devised by Mehrabian and Russell (1974), we compared SAM ratings and judgments made using the semantic differential scale (Bradley & Lang, 1994). Each participant viewed a set of IAPS pictures and made judgments using the 18 bipolar-adjective pairs in the semantic differential for each picture. The resulting matrix of correlations was factor analyzed (see table 2.1), and the solution indicated two factors that accounted for the most variance—pleasure (27%) and arousal (23%). Most important, the correlation between SAM ratings of IAPS pictures and factor scores derived from the semantic differential was very high, indicating that SAM is able to quickly assess these fundamental dimensions of emotion.

A third dimension, accounting for much less variance in semantic evaluation research, was termed *potency* or *dominance* by Osgood et al. (1957). The SAM instrument represents this dimension using a figure that ranges from small (not dominant) to large (dominant). When rating static picture stimuli, dominance ratings are highly correlated with ratings of hedonic valence, with pleasant pictures rated as higher in dominance than unpleasant pictures. We have

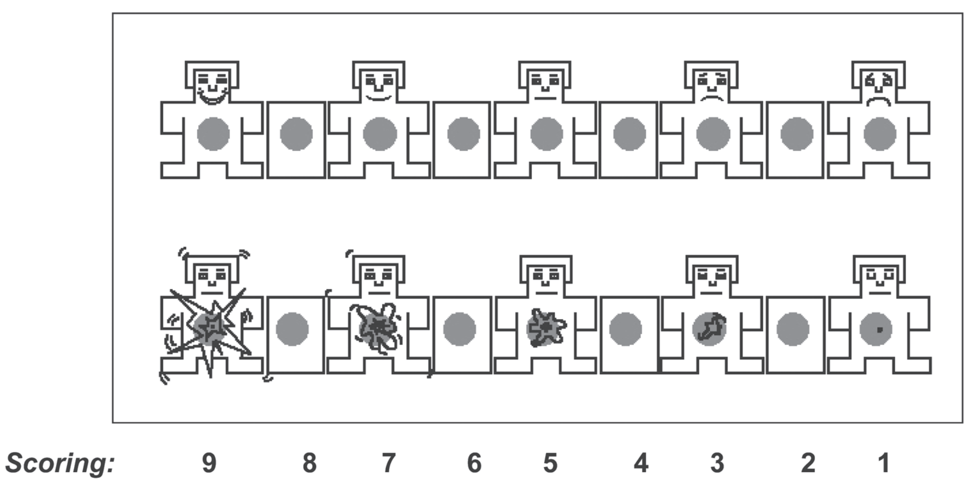

Figure 2.1. The self-assessment manikin (SAM; Lang, 1980) used to acquire ratings of pleasure and arousal for pictures in the IAPS. Each dimension is represented by five graphic figures, and participants can select any of the figures or between any of the figures, making a 9-point scale. *(See color insert)*

Table 2.1
Factor analysis for ratings on the bipolar pairs of the semantic differential when viewing IAPS pictures resulted in two factors of pleasure and arousal that correlated highly with SAM pleasure or arousal rating (Bradley & Lang, 1994)

Semantic Differential	Factor 1 "Pleasure"	Factor 2 "Arousal"	Correlation with SAM pleasure rating
Unhappy-Happy	**.91**	.06	.98
Annoyed-Pleased	**.88**	.07	.99
Despairing-Hopeful	**.86**	.06	.97
Unsatisfied-Satisfied	**.87**	.14	.96
Melancholic-Contented	**.73**	.10	.96
Semantic Differential	Factor 1 *"Pleasure"*	Factor 2 *"Arousal"*	*Correlation with SAM arousal rating*
Unaroused-Aroused	.05	**.83**	.90
Sleepy-Wide Awake	–.05	**.81**	.91
Dull-Jittery	–.21	**.79**	.92
Calm-Excited	–.18	**.79**	.91
Relaxed-Stimulated	–.21	**.77**	.94
Sluggish-Frenzied	–.27	**.77**	.90

speculated that the dominance dimension, which is relatively weak in accounting for variance in evaluative judgments of symbolic stimuli, is perhaps more potent (pun intended) in social interaction. For instance, dominance usually characterizes differences in unpleasant arousing events, with anger characterized by somewhat higher dominance than fear. Nonetheless, both are rated lower in dominance than highly pleasurable events. For symbolic sensory stimuli (e.g., pictures, sounds, words), there is no actual personal interaction in which social potency can play a role. In this case, dominance covaries highly with hedonic valence. Nonetheless, for more event-like stimuli, dominance will clearly account for some portion of variance in evaluative reports.

Normative Rating Procedure

In each IAPS rating study, approximately 60 new exemplars, varying in pleasure, arousal, and semantic content, are presented to approximately 100 participants, half women and half men. Rating sessions are conducted in small groups ranging in size from 8 to 25. For each rated picture set, three different picture orders are used that balance the position of a particular exemplar within the entire series of pictures. In each rating study, pictures are selected that are in color, that have high resolution (e.g., 1024 x 768), and that communicate affective quality relatively quickly.

In addition to the new IAPS exemplars rated in each picture set, three practice pictures are viewed prior to the experimental ratings. These pictures illustrate the range of contents that will be presented and serve to anchor the emotional rating scales. Common anchor points used are: #4200 (woman at beach), #7010 (basket), and #3100 (a burn victim). Each trial begins with a 5 s preparatory cue ("Get ready to rate the next picture"), followed by a 6 s presentation of the to-be-rated picture. Immediately *after* the picture leaves the screen, the participant is given 15 s to make ratings of pleasure, arousal, and dominance using SAM.

Thus far, 16 different rating studies have been conducted. In the first 6 studies, a paper-and-pencil version of the 9-point SAM instrument (Lang, 1980) in booklet format was used to acquire affective ratings; in the last 9 studies, a newer, computer-scorable SAM instrument was used (see Figure 2.1). The list of anchor adjectives from the semantic differential scale for each factor (e.g., stimulated, excited, frenzied, jittery, wide awake, aroused for the SAM "arousal" dimension) are routinely used in the instructions we use (see the appendix to this chapter) to define the concepts of "pleasure" and "arousal" (and "dominance") for the participant. Note that, although we, as researchers, describe the two fundamental dimensions as "pleasure" and "arousal," the SAM scales are not introduced to participants using these umbrella terms. Rather, by using the range of adjectives that the semantic differential provides, one avoids reliance on a single, specific adjective which may be used more frequently in a context associated with a specific hedonic valence.

Affective Space

Figure 2.2 illustrates the *affective space* that results when each picture is plotted in the 2-dimensional space defined by its mean pleasure and arousal rating. There are several characteristic features of this affective space, which appears to be shaped as a "boomerang" when pleasure ratings are plotted on the Y axis or as a U-shaped function when pleasure ratings are plotted on the X axis. The shape of affective space results from the empirical facts that (1) as pictures are rated as more pleasant or more unpleasant, arousal ratings increase as well, and (2) pictures that are rated as neutral tend to be rated low in arousal. These observations are supported by the statistics. Across the entire set of pictures, the linear correlation between pleasure and arousal rating is relatively weak ($r = .28$), whereas the quadratic relationship is stronger (.54) and captures the relationship: Emotional arousal increases as hedonic valence ratings become increasingly more pleasant or unpleasant. These relationships are stable and reliable (Greenwald, Cook, & Lang, 1989).

We have interpreted this space as consistent with the idea that judgments of pleasure and arousal reflect the level of activation in fundamental appetitive and defensive systems. Figure 2.2 (top) illustrates the trajectories through affective space associated with activation of the appetitive motivation system and the defensive motivation system. When neither motivational system is active, judgments anchor the neutral, calm position in affective space. As pictures activate either appetitive or defensive systems more highly, they fall farther

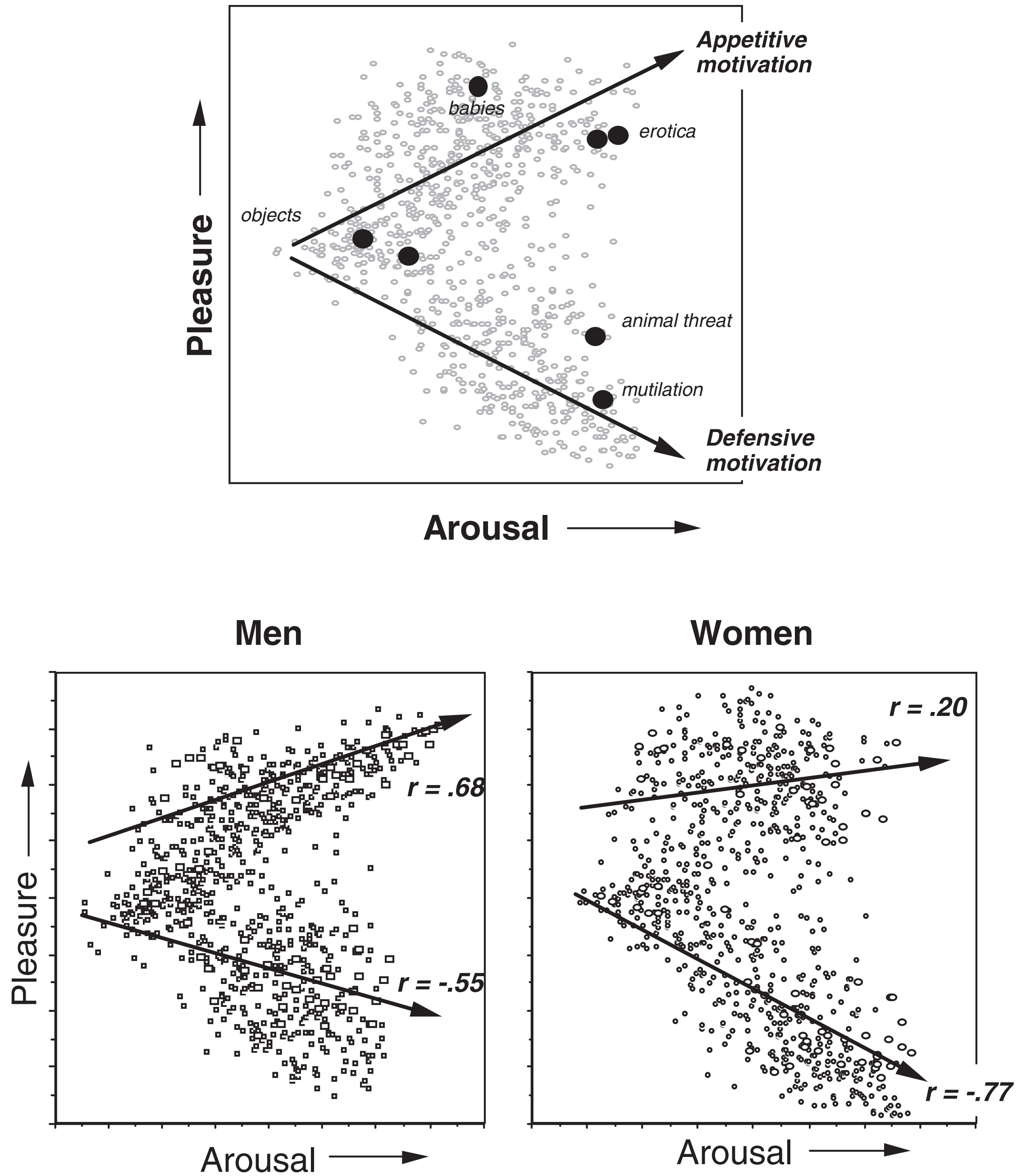

Figure 2.2. Top panel: Each picture in the IAPS is placed in a 2-dimensional affective space on the basis of its mean pleasure and arousal rating. Bottom panel: The affective space for IAPS pictures for men and women are slightly different, with men showing tighter coupling (higher linear correlation) between pleasure and arousal ratings for pleasant pictures, whereas women show a tighter coupling between pleasure and arousal (higher linear correlation) for unpleasant pictures.

along the appetitive and defensive trajectories illustrated in Figure 2.2. Thus pictures of erotica highly activate the appetitive system, whereas threatening stimuli highly activate the defense system.

For picture stimuli, the unpleasant, calm quadrant is the least inhabited sector. The types of contents that currently reside here include pictures depicting pollution, starving children, and cemeteries. Assuming that this portion of space remains difficult to fill, reasonable hypotheses concern the specific type of emotional stimuli (i.e., static visual images) and/or the underlying function of emotion (e.g., extremely aversive stimuli may require high mobilization). As Tellegen (1985) suggests, high negative affect may necessarily involve a high level of arousal.

Whereas the mean ratings for each picture clearly produce a boomerang-shaped affective space, the degree of coupling between pleasure and arousal ratings varies for individuals. A *negative* linear relationship between pleasure and arousal ratings characterizes individuals who tend to primarily rate unpleasant events as arousing; we call this a *negative bias* here. On the other hand, a predominantly *positive* linear relationship characterizes individuals who primarily rate pleasant events as arousing; we call this a *positive bias*. The distribution of intra-subject correlations across studies is quite stable: Typically, half or more of the sample show no significant bias, with approximately 30% showing a negative bias and about 20% showing a positive bias.

Gender affects these distributions in consistent ways. More men (40%) then women (16%) show a positive bias, whereas more women (30%) than men (15%) show a negative bias. Interestingly, men and women do not differ in the proportion of those showing no bias. The inference is that, if deviating from linear independence, men will tend to find pleasant pictures more arousing than unpleasant pictures but that women will tend to find unpleasant pictures more arousing than pleasant pictures. These gender differences are also apparent when separate affective spaces are derived for men and women (see Figure 2.2, bottom). For pleasant pictures, men show a stronger correlation between pleasure and arousal ratings (.68) than do women (.20); conversely, for unpleasant pictures, women show a stronger correlation between pleasure and arousal rating (–.77) than do men (–.55). Thus men are more likely to report high arousal (and pleasantness) when looking at pleasant pictures, whereas women are more likely to report high arousal (and unpleasantness) when looking at unpleasant pictures.

Cross-Cultural Consistency

The shape of affective space is cross-culturally consistent, at least in Western cultures. A significant quadratic relationship between pleasure and arousal was obtained for a subset of IAPS pictures rated in Germany, Sweden, and Italy. One difference among these countries is worth noting—the distribution of *arousal* ratings. Compared with the United States and German samples (which did not differ in mean arousal ratings), Swedish participants generally assigned lower arousal ratings to the pictures, indicating calmer emotional reactions, whereas the Italians rated picturesas significantly more arousing overall. Surprisingly, these data tend to support the general cultural stereotypes that exist for these countries. More important, these data indicate that the IAPS might reliably index cultural differences in emotional disposition, which renders it a potent set of stimuli for investigating cross-cultural affective experience. More complete and current IAPS norms exist for Spain (Molto et al., 1999; Vila et al., 2001) and for Belgium (Verschuere, Crombez, & Koster, 2001), in both of which a similarly shaped affective space was also found. Because SAM is a culture-free, language-free measuring instrument, the picture rating methodology is suitable for use in many different countries and cultures.

Age and Affective Space

Because pictures do not rely on verbal or reading skills, they are also an excellent stimulus for studying emotion in children. In one study, we developed a picture set suitable for viewing by children and compared ratings of pleasure and arousal acquired from young children (7–9 years old), adolescents (13–15 years old), and college students (McManis, Bradley, Berg, Cuthbert, & Lang, 2001). As expected from previous studies, the pleasure and arousal dimensions were linearly independent for adults. A very similar relationship was found for the children and for the adolescents. As in adults, the relationship between pleasure and arousal ratings was significantly quadratic for both the younger children ($r = .64$) and the adolescents ($r = .68$). Strong positive correlations between the children's and adults' ratings were found for both pleasure and arousal, suggesting that children rated the pictures similarly to adults. Given the high correlations between the ratings and the similarity of the relationships between the affective dimensions, the conclusion is that children, adolescents, and adults used SAM in similar ways to organize their emotional experience.

In another laboratory study (Cuthbert, Bradley, Zabaldo, Martinez, & Lang, 1994), women from the ages of 18 to 60 viewed a subset of pictures from the IAPS. Whereas the younger, college-age women produced a typically low and nonsignificant linear correlation between pleasure and arousal, the mature women in this sample (i.e., 45 and older) showed a strong negative bias, with a linear correlation of -.73. Clearly, these mature participants were viewing the emotional world differently (at least as defined by these stimuli). For these women, pleasant events were those that were nonactivating; on the other hand, events that were arousing tended to be rated as unpleasant. This finding (which should be assessed in older males as well) suggests that age may result in fundamental changes in affective space.

IAPS and Picture Content

Although the pictures in the IAPS vary widely in terms of semantic content, they have been selected primarily for their ability to evoke affective reactions. Not surprisingly, the pictures that evoke the most emotion in humans involve those depicting human agents, activities, and events, with the result that over half of the pictures in the IAPS depict people engaged in pleasant, neutral, or unpleasant activities. Figure 2.3 illustrates the proportion of pictures in four basic semantic categories of people, animals, objects (nonliving), and scenes. Overall, unpleasant pictures involving people are rated as more unpleasant (2.6) than are unpleasant pictures of animals (3.4), but both pictures of unpleasant people and animals prompt high arousal ratings (5.7 and 5.8, respectively), suggesting that any mobile agent that threatens human life is viewed as an arousing event.

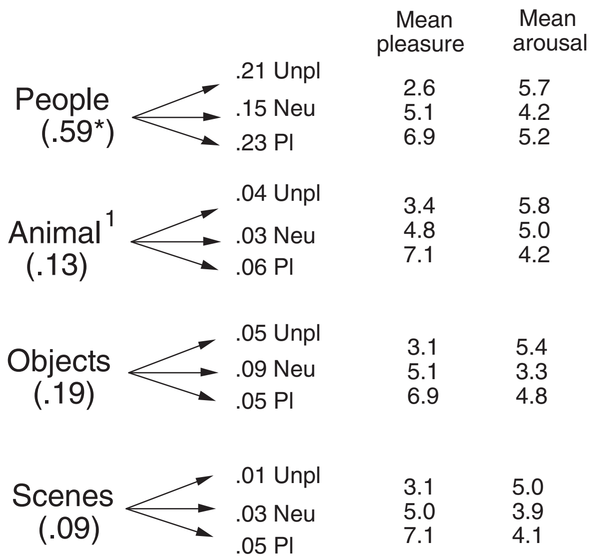

Figure 2.3. The proportion of pictures in the IAPS that occur in each of four basic semantic categories for pictures rated as pleasant, neutral, and unpleasant and the average pleasure and arousal ratings from the normative IAPS ratings (Lang, Bradley & Cuthbert, 2000) for each picture content.

For pleasant pictures, those involving people (e.g., erotica, sports, adventure) tend to be rated higher in arousal (5.2) than are pleasant animals or objects (4.2 and 4.8, respectively), although objects are rated as more arousing than pleasant animals (e.g., puppies, bunnies, deer, etc.). Among the most arousing pleasant objects are pictures depicting things that humans either need (e.g. food) or desire (e.g., money, sports cars). Neutral pictures are more likely to involve objects than people or animals, and, indeed, neutral animals and people are rated as more arousing than nonliving neutral objects.

Figure 2.4 illustrates the affective space for a variety of different picture contents for men and women. Overall, the shape of affective space is again similar for men and women. On the other hand, it is also clear women rate *all* of the unpleasant content as more unpleasant and more arousing than do men, and men tend to rate erotic stimuli (either couples or opposite-sex erotica) as more arousing and more pleasant than do women (Bradley, Codispoti, Sabatinelli, & Lang, 2001). These data are consistent with the individual biases found in reports of pleasure and arousal (as mentioned earlier), as well as with the gender differences in affective space. Importantly, they indicate that women tend to rate all unpleasant contents as more arousing and unpleasant than do men (rather than just specific unpleasant contents), whereas the bias in men for pleasant events is more pronounced for explicitly erotic materials. Taken together, the data support an interpretation of greater defensive reactivity for women and greater appetitive activation—specifically, by erotic materials—for men.

Specific Emotions

As we noted earlier, discrete emotional states—fear, anger, sadness, joy, and so forth—can be understood as specific tactical responses in appetitive and defensive contexts. To determine whether and how IAPS pictures differ in prompting specific emotions, we asked participants to circle the emotions elicited during picture viewing from the following list: Happy, Loving, Sexy, Excited, Romantic, Satisfied, Comfortable, Free, Amused, Playful, Nurturing, Bored, Confused, Irritated, Sad, Angry, Afraid, Anxious, Pity, Disgusted, Impatient (see Bradley, Codispoti, Sabatinelli, & Lang, 2001). An effort was made to include a wide range of both pleasant and unpleasant emotional states, despite the fact that unpleasant states often dominate in basic lists of emotion.

Across participants, many different emotion labels were selected for the same picture, suggesting no clear one-to-one relationship between picture content and discrete emotion. Table 2.2 lists the two most frequently selected emotion labels for each picture content, together with the proportion of participants who selected that label. The highest agreement was obtained for pictures depicting contamination (e.g., spoiled food, dirty toilets, etc.) and mutilation, which were both rated as evoking disgust by men and women. Threatening contents were often labeled as eliciting fear, but more so among women. Similarly, women were more likely to indicate feeling "happy" when viewing pictures of families and nature scenes than were men.

Men and women were most different in the specific emotions they indicated feeling when viewing erotica. Whereas both men and women rated erotic couples as making them feel "romantic" and "sexy," men indicated feeling "sexy" and "excited" when viewing erotic women, whereas women showed much less agreement among themselves, with the most frequent reports indicating feeling "amused" and "embarrassed" when viewing erotic men. These data agree with the SAM pleasure and arousal ratings, in which men tend to rate opposite-sex erotica as more pleasant and more arousing than women do. On the other hand, whereas women also rate erotic couples as less pleasant and less arousing than do men, they selected similar labels (e.g., "sexy" and "romantic") when describing their affective experience. These data are consistent with the idea that intensity of appetitive or defensive motivation is the foundation of emotion, with different discrete emotions used to describe different tactical responses in similar motivational states.

Psychophysiology and the Motivational Organization of Emotion

Evaluative reports are clearly sensitive to dimensional variations in the IAPS pictures. On the other hand, these subjective judgments are just one way of tapping a person's affective experience. Indeed, the inherent plasticity in language and

UNPROOFED PAGES

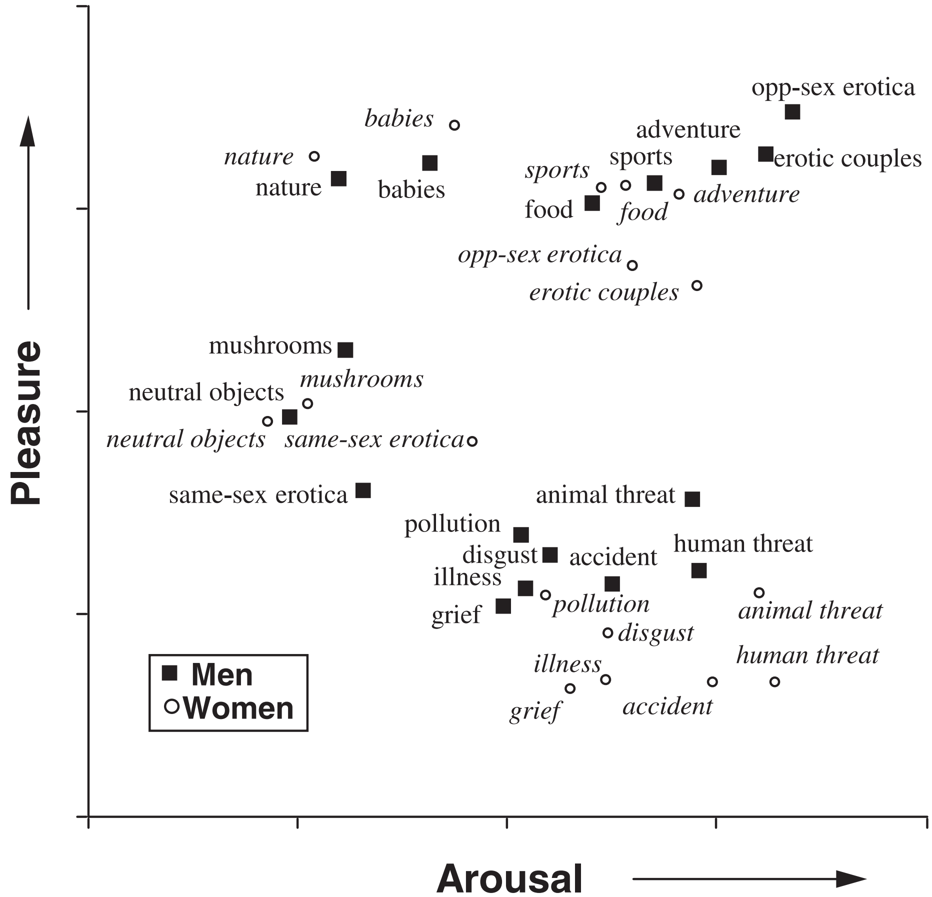

Figure 2.4. Specific picture contents in the IAPS plotted in affective space for men and women.

Table 2.2
List of the most frequent specific emotion descriptors selected when viewing different picture contents in the IAPS and the proportion of men and women selecting that specific emotion to describe their affective experience

Picture Content	*Women*	*Men*
Erotica		
Erotic couples	Romantic (.41), Sexy (.37)	Romantic (.47), Sexy (.44)
Opposite-sex erotica	Amused (.36), Embarrassed (.22)	Sexy (.50), Excited (.40)
Same-sex erotica	Bored (.56), Confused(.26)	Bored (.56), Confused (.17)
Adventure	Excited (.63), Free (.66)	Free (.61), Excited (.55)
Sports	Excited (.69), Free (.60)	Excited (.55), Free (.52)
Food	Happy (.37), Satisfied (.17)	Happy (.27), Excited (.17)
Families	Happy (.79), Loving (.78)	Happy (.58), Loving (.58)
Nature	Free, (.76), Happy (.60)	Free (.56), Happy (.41)
Pollution	Disgust (.56), Irritation (.43)	Disgust (.34), Irritation (.26)
Loss	Sad (.79), Pity (.56)	Sad (.61), Pity (.59)
Illness	Pity (.67), Sad (.69)	Sad (.51), Pity (.58)
Contamination	Disgust (.88), Irritation (.50)	Disgust (.78), Irritation (.40)
Accidents	Sad (.63), Pity (.55)	Sad (.49) , Pity (.50)
Mutilation	Disgust (.81), Sad (.47)	Disgust (.75), Pity (.42)
Animal Threat	Afraid (.69), Anxious (.31)	Afraid (.42), Anxious (.23)
Human Threat	Afraid (.67), Angry (.42)	Afraid (.37), Angry (.35)

List of emotion descriptors included: Happy, Loving, Sexy, Excited, Romantic, Satisfied, Comfortable, Free, Amused, Playful, Nurturing, Bored, Confused, Irritated, Sad, Angry, Afraid, Anxious, Pity, Disgusted, Impatient (Bradley, Codispoti, Sabatinelli, & Lang, 2001).

its sensitivity to experimental cues raise the possibility that participants may primarily rate the pictures in a socially appropriate manner. If this were the case, one might expect to find a divergence between evaluative judgments and other indices of emotional response. As Lang (1968) originally noted, correlations between measures of emotion are typically modest. Part of the problem may be related to the lack of standardized stimuli for assessing concordance to the same emotional cues in different response systems.

Physiology and the Individual's Ratings

Using the IAPS stimuli, covariation between an individual's evaluative judgments and other relevant emotional responses can easily be assessed. One method is to rank the pictures on the basis of the pleasure or arousal ratings made by each individual. Once the pictures are ranked for each person, affective responses in other systems (e.g., skin conductance) are averaged at each rank across participants. Note that the picture rated as most unpleasant (or pleasant) will vary across individuals—it might be an attacking dog for one person, a car accident for another. This method recognizes the diversity in affective experience across individuals and allows one to assess the covariation between evaluative judgments and other affective reactions, providing a metaphorical "emotional psychophysics" that parallels Stevens' (1961) classic method relating subjective reports of stimulus magnitude to the physical intensity of the stimulus.

In two experiments that examined the relationships between evaluative judgments and physiology (Greenwald et al., 1989; Lang, Greenwald, Bradley, & Hamm, 1993), clear, reliable relationships emerged, as Figure 2.5 illustrates. First, the pattern of facial corrugator supercilii muscle activity strongly parallels reports of *pleasure.* As pictures are rated as increasingly unpleasant, activity in the corrugator ("frown") muscle, located just above the eyebrow, also increases. Moreover, pictures rated as most pleasant prompt decreased corrugator EMG activity, providing a bidirectional change from neutral pictures. Identical relationships between corrugator EMG activity and pleasure ratings were found by Larsen, Norris, and Cacioppo (2003) for IAPS pictures, as well as when listening to affective sounds or reading affective words. Changes in the zygomaticus major ("smile") EMG activity also covary with reports of pleasure, although less strongly than for corrugator EMG activity. Moreover, for the most unpleasant pictures, EMG activity measured over this zygomatic muscle shows a slight increase. These relationships were also replicated by Larsen et al. (2003) for pictures, as well as for sounds and words. Skin conductance changes, on the other hand, strongly covary with reports of emotional *arousal,* as does the magnitude of a late positive potential that begins around 400 ms in the event-related potential measured at picture onset (see Figure 2.5, bottom left). These relationships suggest that IAPS pictures prompt measurable emotional engagement that relates to evaluative judgments and that the dimensional organization of emotion is well captured by systematic variations in autonomic, somatic, and cortical activity.

Physiology and Normative Ratings

In addition to assessing how bodily reactions covary with each individual's judgments of pleasure and arousal, a second, and perhaps more typical, method for using the IAPS to study emotion is to select sets of pleasant, neutral, and unpleasant pictures based on the normative IAPS ratings of pleasure and arousal (Lang, Bradley & Cuthbert, 2004). The pattern of affective modulation in facial EMG, cardiovascular, electrodermal, and electrophysiological activity elicited by standard sets of affective pictures mirrors those obtained when assessing individual covariation.

Facial EMG

Again, a very reliable measure of hedonic valence (pleasure) is the amount of activity measured over the corrugator muscle (see Figure 2.6, top left). Compared with viewing neutral pictures, activity in this muscle increases (compared with a baseline immediately preceding picture onset) when viewing unpleasant pictures and decreases for pleasant pictures. Moreover, both men and women show significant changes in this facial muscle when viewing unpleasant pictures (Bradley, Codispoti, Sabatinelli, & Lang, 2001). Among unpleasant pictures, corrugator EMG activity is enhanced for the most unpleasant contents (see Figure 2.6, top right), with the largest changes prompted by pictures of mutilated bodies and contamination (Bradley, Codispoti, Cuthbert, & Lang, 2001). The least corrugator EMG activity is found when viewing pleasant, calm stimuli, such as nature scenes and babies or families.

Activity measured over the zygomaticus major or "smile" muscle (see Figure 2.6, bottom left) also varies with hedonic valence, but somewhat more weakly. A few specific pleasant contents seem to prompt the most EMG activity over this muscle (see Figure 2.6, middle left), including pictures of babies, puppies, families, and, to some extent, food, particularly among female participants (Bradley, Codispoti, Cuthbert, & Lang, 2001). For men, little activity is found over the zygomatic muscle when viewing any pleasant content. Moreover, for both men and women, measurable activity in this muscle is obtained when viewing some unpleasant contents, including human or animal threat and contamination, as the zygomatic muscle can also be part of a more widespread facial grimace.

Based on Duchenne's work, Ekman (1993) suggested that an authentic smile involves activity around the eyes, as well as in the lower face, whereas a faked smile involves only the mouth region. When activity over the orbicularis oculi muscle (i.e., beneath the eye) is measured during picture viewing, together with zygomatic EMG (and corrugator EMG), specific patterns of facial activity result (Bradley, Codispoti, Cuthbert,

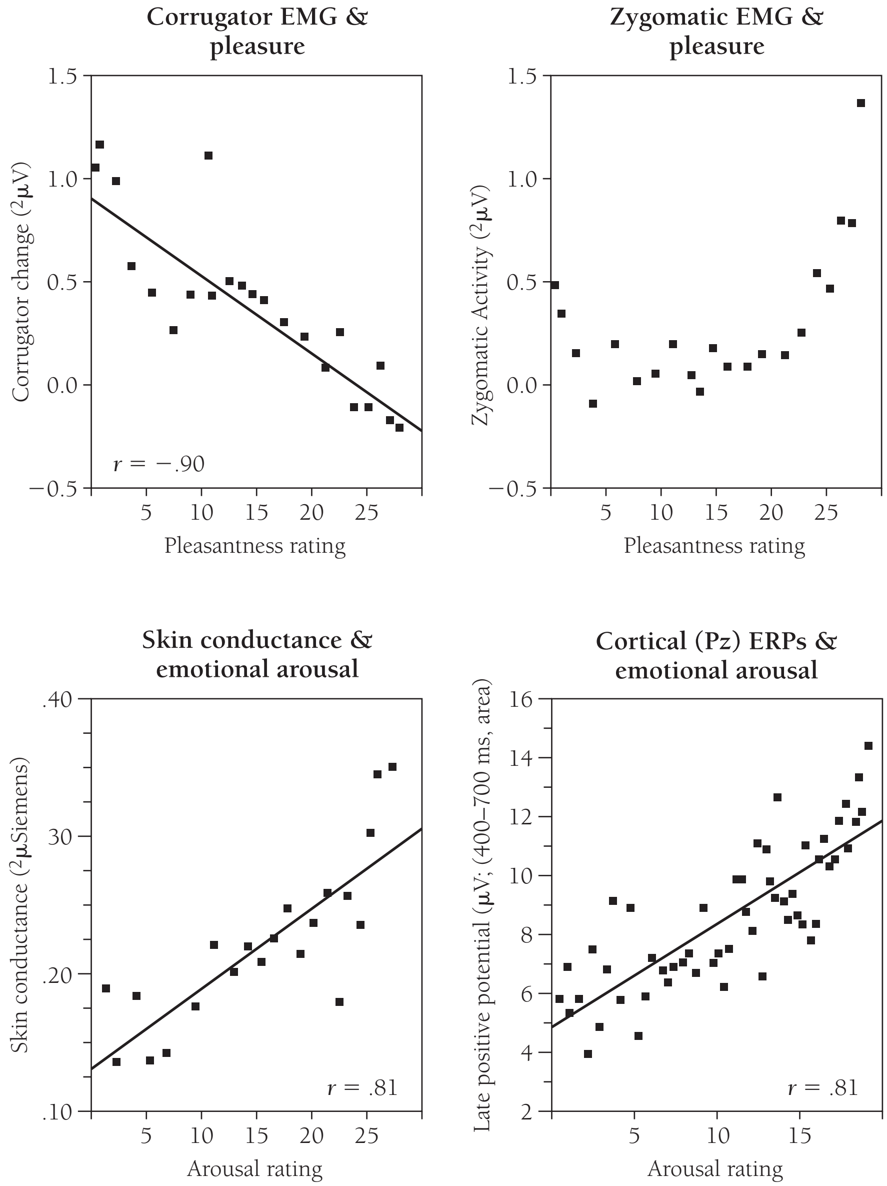

Figure 2.5. Covariation between evaluative judgments and specific psychophysiological responses. Facial EMG activity (measured over the corrugator "frown" and zygomatic "smile" muscles) covary with changes in pleasantness ratings, whereas skin conductance change and the magnitude of a late (400–700 ms) positive component in the event-related potential are more closely associated with changes in rated arousal (Cuthbert et al., 2000; Greenwald et al., 1989).

& Lang, 2001). Pleasant pictures of babies and families prompt heightened activity over both the zygomatic and orbicularis oculi muscles, consistent with the notion that these contents elicit an authentic "Duchenne" smile. Activity over the orbicularis oculi muscle is also enhanced when viewing unpleasant contents, together with increased corrugator EMG activity, but particularly for those contents that people tend to label as "disgusting" (e.g., mutilation and contamination). Taken together, these data suggest that coactivation in the zygomatic and orbicularis oculi muscles indicates an authentic smile, whereas coactivation of the corrugator and orbicularis oculi muscles is linked to a facial expression of disgust. On the other hand, all unpleasant contents were associated with increased corrugator EMG activity, suggesting that facial muscle is is reliably engaged during aversive picure viewing.

Skin Conductance

Skin conductance responses are reliably enhanced when viewing pleasant or unpleasant, compared with neutral, pictures (see Figure 2.7). Thus, this phasic sympathetic activity is a good index of the arousal dimension of motivation. On the other hand, these electrodermal responses habituate quite rapidly and are typically engaged by only the most arousing pleasant and unpleasant contents. For pleasant pictures, as Figure 2.7 illustrates, skin conductance responses are significantly elevated primarily for pictures of erotica (Bradley, Codispoti, Cuthbert, & Lang, 2001). Although men typically show *larger* conductance responses when viewing erotica than do women, reliable increases in skin conductance when viewing erotic pictures are obtained for women as well (Bradley, Codispoti, Sabatinelli, & Lang, 2001). For unpleasant

UNPROOFED PAGES

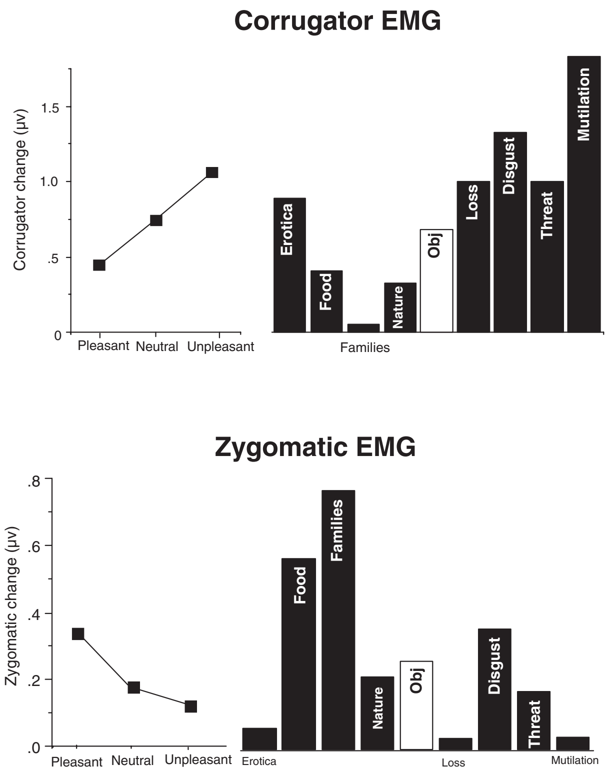

Figure 2.6. Facial EMG changes (rectified, integrated EMG) for sets of pictures selected on the basis of normative ratings of pleasure (left panel) and for specific picture contents (Bradley, Codispoti, Cuthbert, & Lang, 2001).

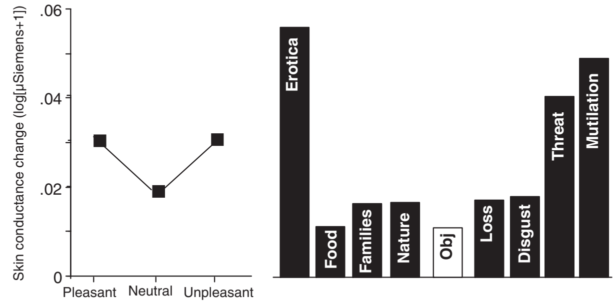

Figure 2.7. Skin conductance activity for sets of IAPS pictures selected on the basis of normative ratings of pleasure (left panel) and for specific picture contents (Bradley, Codispoti, Cuthbert, & Lang, 2001).

contents, skin conductance activity is again heightened for the most arousing contents—pictures of human threat, animal threat, and mutilated human bodies (see Figure 2.7).

These data suggest that eliciting a measurable electrodermal response depends on relatively high motivational activation. Given the association between electrodermal reactivity and sympathetic nervous system activity, one hypothesis is that measurable sympathetic ("fight or flight") activation depends on relatively intense motivational activation. More important, the data suggest that experiments that do not include highly arousing erotic and mutilation/threat contents will prompt little differentiation in skin conductance activity. In addition, whether pleasant or unpleasant pictures result in similar electrodermal magnitude will depend on the specific content and proportion of highly arousing pictures in each hedonic valence category in the study. For instance, experiments that include few erotic but many threatening stimuli will find increased skin conductance for unpleasant, compared with pleasant, pictures rather than equivalent responses for both pleasant and unpleasant stimuli.

Heart Rate

When viewing pictures for a 6 s duration, a typical triphasic pattern of heart rate response is obtained, with an initial deceleration (usually taken as an index of orienting, or intake; Graham, 1973) followed by an acceleratory component and then by a secondary decelerative component. Figure 2.8 illustrates this cardiac pattern. Hedonic valence contributes to the amount of initial deceleration, as well as to the initial acceleratory activity, with unpleasant stimuli producing more initial deceleration and pleasant stimuli producing greater peak acceleration (Greenwald et al., 1989). As Figure 2.8 illustrates, greater initial heart rate deceleration is associated with viewing all unpleasant contents (Bradley, Codispoti, Cuthbert, & Lang, 2001), suggesting that, regardless of arousal, unpleasant material prompts greater initial orienting and attention. Overall, pleasant pictures tend to modulate the second, acceleratory component of the cardiac response to pictures, with increased peak acceleration, compared with viewing unpleasant pictures (Greenwald et al., 1989).

Cardiac reactions to pleasant pictures can, however, show substantial initial deceleration, especially when viewing arousing pleasant contents. Figure 2.8 illustrates data from a study in which participants viewed 24 pictures (8 pleasant, 8 neutral, 8 unpleasant) on one day and returned a week later to view 24 new pictures. For unpleasant pictures, initial deceleration is consistently obtained on both occasions. For pleasant pictures, on the other hand, initial deceleration is enhanced during the second session, with the most arousing contents, for example, erotica and adventure, prompting clear deceleration during the second viewing. One hypothesis is that, following exposure to the range of picture contents, participants voluntarily direct attention (orient) to pleasant stimuli, whereas this type of orienting is relatively more automatic for unpleasant contents. We have found that experiments that present a large number of pictures (i.e., allowing familiarity with picture contents), or that explicitly cue picture content, will tend to obtain sizable initial heart rate deceleration for highly arousing pleasant pictures. On the other hand, significant cardiac deceleration is a hallmark of affective processing for unpleasant pictures in all experimental contexts.

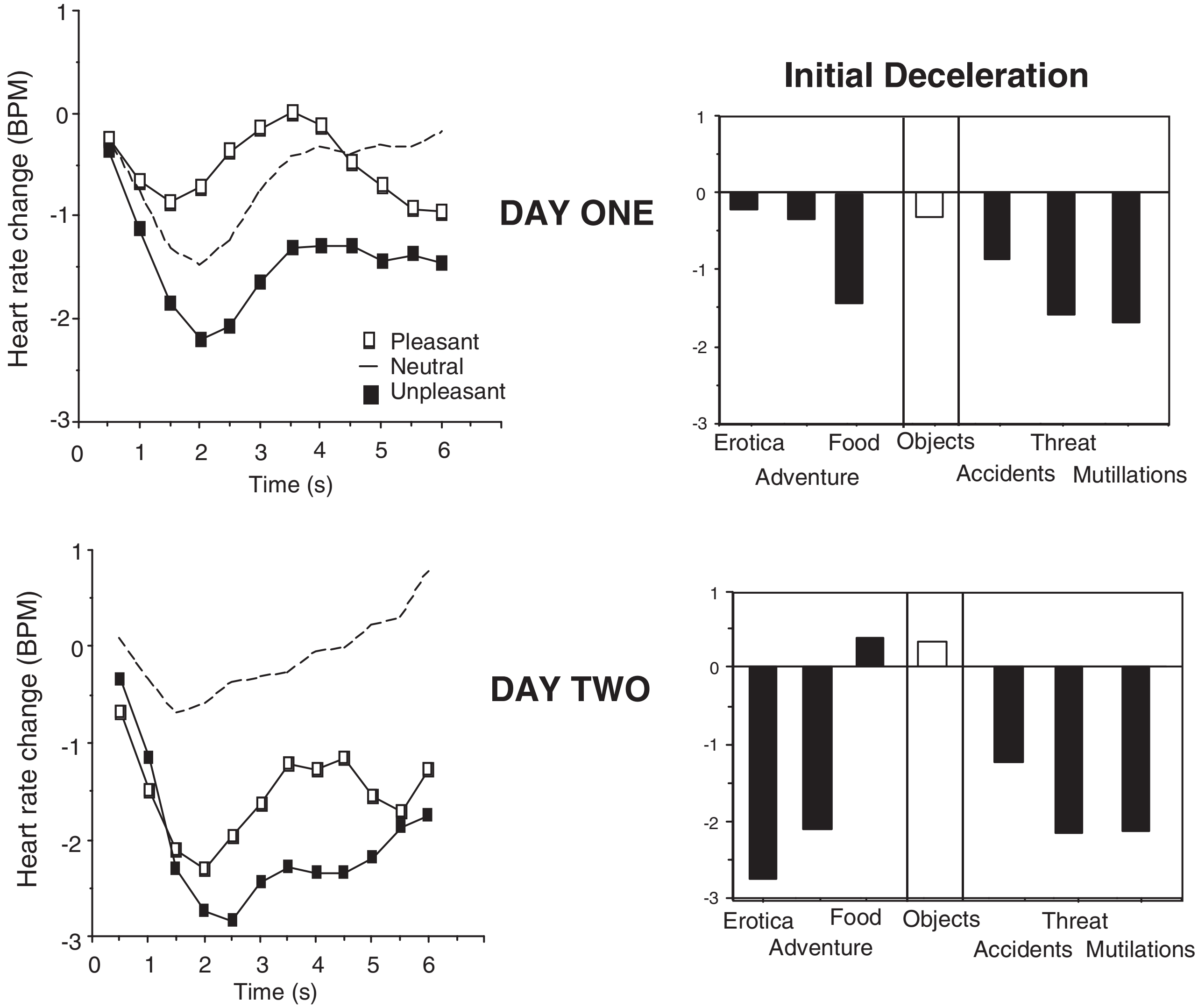

Figure 2.8. The triphasic cardiac waveform prompted by a 6 s presentation of IAPS pictures selected on the basis of normative ratings of pleasure (*left*) and for specific picture contents (*right*) for two sets of novel pictures viewed 1 week apart (first visit, *top*; second visit, *bottom*).

The modulation and shape of the cardiac waveform during picture viewing is highly dependent on the duration and presence of a sensory foreground. Pictures shown briefly for 500 ms result in a very brief decelerative response that does not differ as a function of hedonic valence (Codispoti, Bradley, & Lang, 2001). Thus cardiac activity during picture viewing appears to be tightly coupled to sensory information processing (i.e., orienting) and does not vary reliably with affect when picture presentation is brief and the stimulus no longer perceptually available. Consistent with this hypothesis, initial deceleration decreases quickly and ceases to be modulated by affective valence when the same pleasant, neutral, and unpleasant pictures are shown repeatedly in an experiment (Bradley, Lang, & Cuthbert, 1993), a context in which information intake is presumably low following repetitive exposure.

Cortical ERPs and Slow Wave Activity

When electrophysiological measures are assessed during picture viewing, specific event-related potentials and sustained positive slow wave activity are observed in response to emotionally arousing picture stimuli, irrespective of hedonic valence (Crites & Cacioppo, 1996; Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Palomba, Angrilli, & Mini, 1997). Perhaps the most common finding, illustrated in Figure 2.9, is the modulation of a late positive potential, starting 300–400 ms after picture onset, that is larger when viewing either pleasant or unpleasant, compared with neutral, materials. Using a slow time constant, a sustained positive slow wave can additionally be seen that is maintained until the picture is terminated (Cuthbert et al., 2000). Topographically, the difference in the late positive potential due to affect is maximal over centroparietal cortex and is often more pronounced over the right hemisphere, as illustrated in Figure 2.9.

The magnitude of the late positive potential is greatest for pictures that are rated as most arousing, including, for pleasant pictures, erotica (and romance) and, for unpleasant pictures, mutilated bodies and human or animal threat (Schupp et al., 2004). Thus in a number of ways modulation of this ERP component is similar to that obtained in the skin conductance response—enhanced for the most arousing picture contents. The late positive potential is similar in topography to the P3 component that is obtained slightly earlier (i.e., starting around 300 ms) for simpler stimuli (e.g., letters, words, simple visual figures) and that is often interpreted as reflecting differences in attention or resource allocation (see Naatanen, 1988, for a overview). Assuming a slight delay in the timing of this component due to the relatively higher information load in the IAPS pictures, the late positive potential can be interpreted as reflecting increased attention for motivationally relevant stimuli (Lang et al., 1997). Consistent with the interpretation, emotionally arousing pictures are rated as more interesting than neutral stimuli, are voluntarily viewed for a longer period of time, and show inhibition of reaction time (RT) to simple or startling probes, all of which suggest that emotionally engaging pictures may elicit more attention or require additional resources (Bradley, Cuthbert, & Lang, 1999; Greenwald et al., 1989).

Blood-Oxygenation-Level-Dependent Neural Activity

Consistent with the ERP data, emotional pictures, whether pleasant or unpleasant, prompt greater blood-oxygenation-level-dependent (BOLD) changes than neutral pictures in occipital (particularly right hemisphere) cortex (Lang et al., 1998), including fusiform cortex, lateral occipital cortex, and medial parietal cortex, when pictures are shown to participants in the MRI scanner. Interestingly, BOLD signal changes vary directly with the rated level of arousal of different picture contents (Bradley et al., 2003) and are strikingly similar for both men and women (Sabatinelli, Flaisch, Bradley, Fitzsimmons, & Lang, 2004). The largest changes in the BOLD signal in visual fusiform cortex are obtained for highly arousing contents of erotica, threat, and mutilation, with significantly lower activity for pictures of babies, happy animals, and neutral objects. One hypothesis is that increased activation in these secondary visual cortex structures reflects reentrant processing from subcortical structures, particularly the amygdala. Indeed, Amaral, Price, Pitkanen, and Carmichel (1992) describe substantial input and output connections linking visual cortex to amygdaloid nuclei in the primate.

In a recent study (Sabatinelli, Bradley, Fitzsimmons & Lang, 2005), we measured BOLD activity in the amygdala and in the fusiform cortex for a variety of different picture

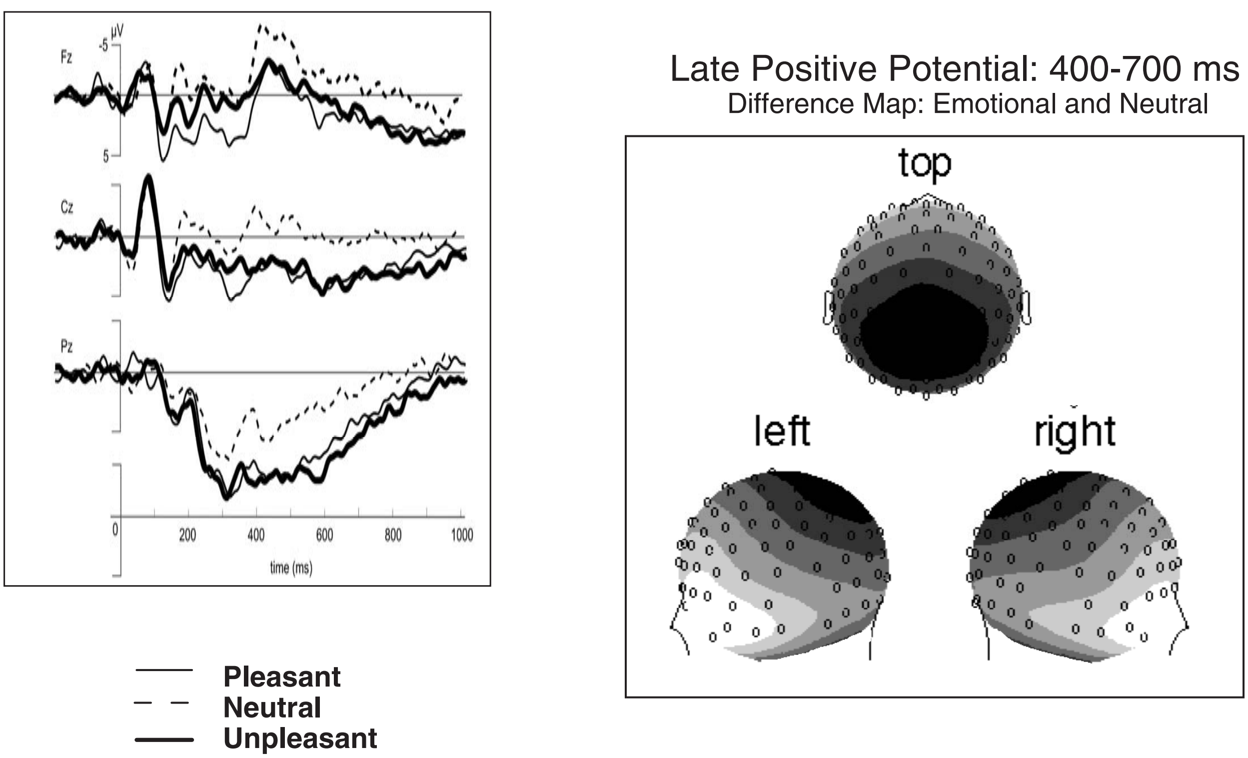

Figure 2.9. The event-related potential measured at Pz, Cz, and Fz during a 6 s presentation of IAPS pictures selected on the basis of normative ratings of pleasure, and the scalp distribution of the difference in a late positive potential (400–700 ms following picture onset) illustrating its centroparietal maximum (Keil et al., 2002).

contents, expecting significant covariation if these structures reflect motivational engagement. As Figure 2.10 (left) illustrates, significant activation was found in both the amygdala and the fusiform cortex when viewing affective pictures. Overall, the magnitude of BOLD signal change during picture viewing was higher in visual cortex, as might be expected for these sensory stimuli. Nonetheless, in both structures, emotionally arousing pictures prompted greater signal change than pictures rated lower in arousal. When BOLD activity was normalized within each structure, the pattern of activity was impressively similar across picture contents, with increases in fusiform activity clearly related to increased amygdala activity, and vice versa. Although correlational in nature, these data are consistent with the hypothesis that increased sensory activation during affective picture viewing is related to the amount of activation in subcortical, particularly amygdalar, regions. Moreover, highly arousing *pleasant* contents, as well as unpleasant pictures, prompted clear, measurable signal change in the amygdala, suggesting that this structure is not solely reactive to aversive cues.

Additional Affective Responses

A host of other affective reactions have been investigated in the context of viewing IAPS pictures, including modulation of the startle reflex (see Bradley, Cuthbert, & Lang, 1999, for an overview), neuroendocrine reactions (e.g., Blake, Varnhagen, & Parent, 2001; Codispoti et al., 2003), respiratory changes (Ritz, 2004), metabolic brain changes (e.g., Lane, Reiman, Ahern, Schwartz, & Davidson, 1997), memory performance (Bradley, Greenwald, Petry, & Lang, 1992) and others. Many of the basic findings summarized in this chapter have been replicated and extended by researchers investigating both basic and applied issues in the study of emotion, which should encourage new researchers to consult the database regarding affective reactions to IAPS pictures prior to designing new studies In this way, the field can make systematic progress in understanding emotion, rather than producing parallel lines of research that do not benefit from existing knowledge.

Some IAPS Issues

Safety and Effectiveness

In order to study emotion, it is first necessary to induce an emotional state or reaction in the laboratory context. The IAPS picture stimuli are designed to do so in a safe, noninvasive manner, eliciting affective reactions in a controlled setting with the mental health of the participant in mind. Typically, insti-

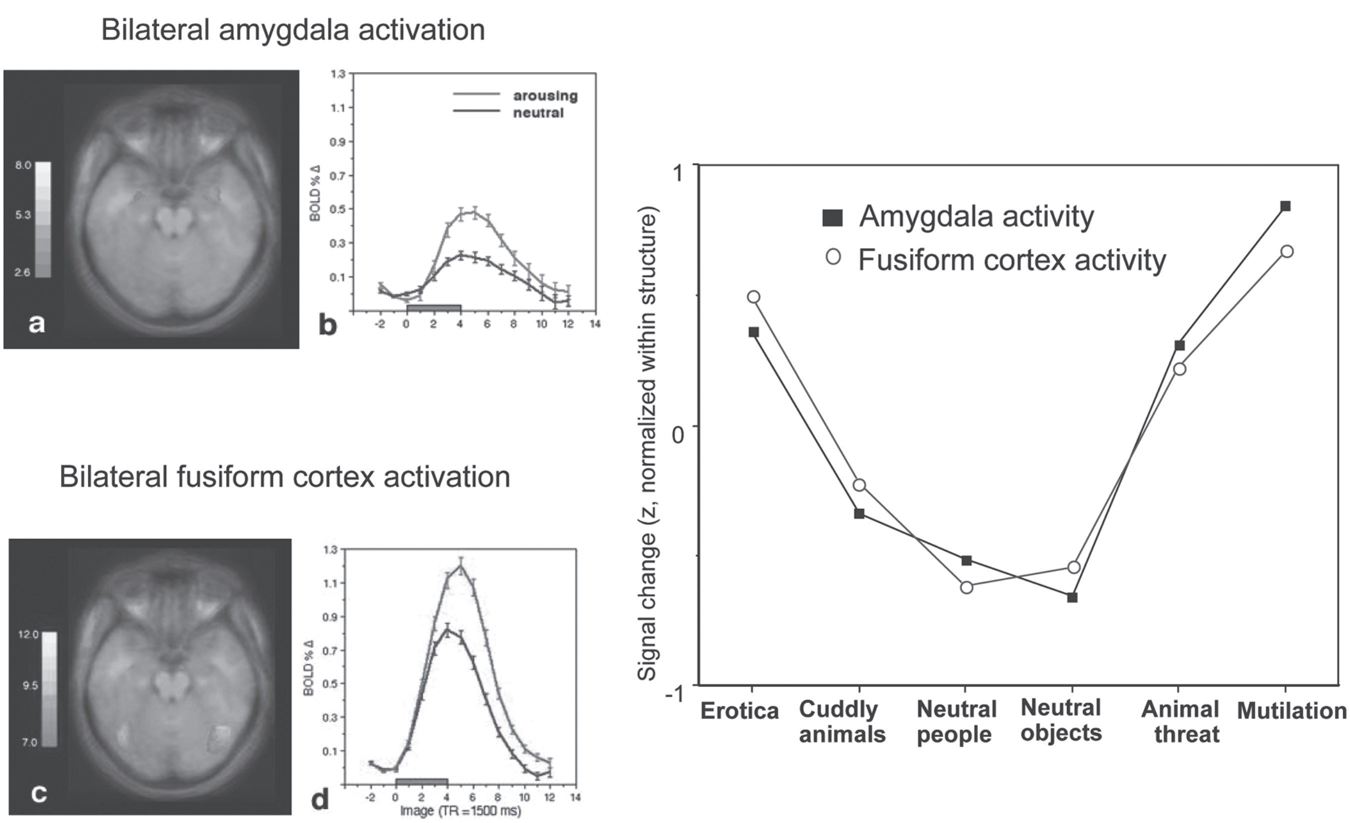

Figure 2.10. Neural activity measured in the amygdala (top left) and fusiform cortex (bottom left) using fMRI is increased when viewing emotionally arousing, compared with neutral, pictures, and both covary similarly with specific picture contents (Sabatinelli et al., 2004). *(See color insert)*

tutional review board panels are often concerned with whether presenting IAPS pictures to participants is safe, asking: Are IAPS pictures *too strong* for inducing emotion in the lab? On the other hand, scientists and researchers are more likely to wonder whether IAPS pictures are effective, often asking: Are pictures *strong enough* to induce emotion in the lab? Similar responses apply to both queries.

The IAPS pictures vary in emotional provocation, from none or very little to those that are judged to evoke pleasant or unpleasant arousal. The pictures in the IAPS do not exceed in provocation the types of images that can be found on television or that are routinely seen in magazines and newspaper headlines (e.g., people brandishing guns at the viewer or dead victims of war as seen on a news program; the bloody organs in an open-heart operation on a medical channel; the erotic pictures in advertisements and on cable television stations). In fact, the most evocative IAPS images represent the sexual and violent content that people often actively seek out in both television viewing and in printed matter.

The intensity of affective responses to pictures is less than that elicited by the anticipation of real pleasures or actual dangers, as well as by actual pain or real erotic encounters. Compared with the anticipatory physiological reaction when a physician approaches a patient with a hypodermic needle, for instance, physiological reactions induced when viewing unpleasant pictures are quite small. Pictures are, after all, symbolic, rather than actual, stimuli. No matter how frightening a picture is, it cannot physically threaten; no matter how enticing an erotic or a food picture is, it will never satisfy. Nonetheless, it is indeed fortunate that, despite reduced reactions, these relatively small-scale responses are significantly correlated with judgments of pleasure and arousal, varying, presumably, in type and intensity with the more extended reactions caused by actual emotional events. Using pictures, emotion can be probed and studied in the laboratory with relative safety.

Of course, prior to picture presentation, participants should be informed about the range of content that may be presented (e.g., "Some of the pictures may include content that can be considered objectionable, such as sexually explicit pictures and violent pictures [threatening people, disfigured human bodies].") And, with the possible exception of certain studies with clinical populations, participants should be discouraged from participating if they are apprehensive about some specific content (e.g., a small percentage of normal people are blood phobic). The participant's option in this case should be exactly the same as when one chooses not to turn on a particular television program, see a particular movie, or buy a particular magazine. It is well to keep in mind, furthermore, that even if one is eventually surprised by the impact of a picture, one can always close one's eyes—a simple option that is not often available in real life when emotionally provoked and a reason, perhaps, to monitor eye movements during picture viewing if possible.

After more than a decade of study, the research and clinical communities now have vast experience with these materials. At the University of Florida alone, more than 3,000 normal participants have viewed a range of these picture stimuli. The IAPS has been used widely in clinical settings with a great variety of patients, including those with neurological disorders (e.g., Siebert, Markowitsch, & Bartel, 2003), PTSD and other anxiety disorders (e.g., Amdur, Larsen, & Liberzon, 2000; Shapira et al., 2003), drug abuse and dependency issues (e.g., Geier, Mucha, & Pauli, 2000; Gerra et al., 2003;), depression and anhedonia (e.g., Dichter, Tomarken, & Baucom, 2002), psychopathy (Patrick, 1994), food-related disorders (e.g., Drobes et al., 2001), and schizophrenia (e.g., Quirk & Strauss, 2001). Although emotionally arousing pictures prompt affective reactions, these evaluative and physiological responses are relatively transient—present during and shortly after viewing, but subsiding rapidly thereafter. Importantly, there have been no reported instigations or exacerbations of psychiatric conditions attributable to mere picture viewing.

Physical and Perceptual Characteristics

Because they are natural photographs, IAPS pictures can differ in perceptual characteristics, including color composition, brightness, contrast, luminosity, spatial frequency, and so forth. These physical differences can be controlled for in specific picture sets by using the many different digital editing software packages currently available (e.g., Photoshop). Pictures selected for use in specific studies can be adjusted to remove purely physical differences among stimulus sets. Importantly, whether pictures are presented in color or in gray scale has proven to have little or no effect on many indices of affective engagement, including autonomic, somatic, and BOLD neural activity (Bradley, Codispoti, Cuthbert, & Lang, 2001; Bradley et al., 2003), suggesting that presentation in gray scale might be a useful method for removing differences due sheerly to color composition. Differences in brightness and contrast, which together relate to luminosity, are easy to adjust using existing digital photo software, and spatial frequency (a measure of visual complexity) can be calculated and balanced across stimulus sets (e.g., Sabatinelli, Flaisch, Bradley, Fitzsimmons, & Lang, 2004).

Distribution and Access

The IAPS is currently distributed by the NIMH Center for the Study of Emotion and Attention (at the University of Florida) in digitized form on CD-ROM disks, together with files containing pleasure and arousal ratings for men and women. Over a thousand researchers worldwide have requested and received copies of the IAPS since its inception. It has been used in nearly every area of emotion science—psychophysiology, cognitive psychology, neuroscience, social psychology, neuropsychology, psychiatry, clinical psychology, and so forth. The IAPS continues to be distributed free of charge to academic investigators for their private use in nonprofit research; the IAPS is not available to corporate or other nonacademic research enterprises. And, the IAPS continues in its development; new experiments consistently require a larger number of pictures, both in terms of providing appropriate controls and in attaining appropriate cell sizes for experimental manipulations. We therefore continue to seek and to add new exemplars to the IAPS, routinely conducting new rating studies to provide additional norms for pleasure and arousal. We have noted that researchers will often add new exemplars of their own to the IAPS in order to increase the number of pictures in a particular category or to target a particular category (e.g., alcohol-related cues). Continued development of the IAPS would benefit greatly from a communal effort in which emotion scientists who develop new materials would send them to us (via CD) for possible inclusion in the IAPS. The only requirements for appropriate stimuli are that the pictures are in color and at least 1024 x 768 pixels in resolution.

Conclusion

Pictures may *truly* be worth a thousand words—certainly, in the alacrity with which they elicit emotional engagement. As visual cues, the perceptual information in pictures match many features of the actual objects they represent. Thus emotionally arousing contents capture attention promptly and activate the motivational systems on which human emotion is founded. With brief exposure, human participants report emotional experiences that vary reliably in pleasure, emotional arousal, and even in reports of specific emotional states. Importantly, the pictures also prompt autonomic and somatic reflexes of defense and appetite that confirm affective engagement. Moreover, electroencephalographic and neuroimaging studies clearly show enhanced activation to emotional pictures—increasing with emotional arousal—in visual cortex and in subcortical circuits implicated in attention and action. Thus the goal is well met: Experiments using pictures in the IAPS provide an increasingly sophisticated database regarding affective reactivity. Furthermore, the picture-viewing context has shown itself to be a powerful yet eminently controllable methodology that advances understanding of mechanism in normal emotion and potentially in pathological states. Finally, the availability of a large set of standardized affective stimuli to emotion researchers, each identified by number and with accompanying evaluative data, provides a foundation for exact replication and a true accumulation of knowledge across laboratories and paradigms—a distinct need for our young science.

Appendix: Instructions for Using SAM to Rate Pleasure and Arousal

The first SAM scale is the happy-unhappy scale, in which SAM ranges from a smiling figure to a frowning figure. At one extreme of this scale, you feel happy, pleased, satisfied, contented, hopeful. If you feel completely happy while viewing the picture, you can indicate this by filling in the bubble in the figure on the left. The other end of the scale indicates that you feel completely unhappy, annoyed, unsatisfied, melancholic, despairing, bored. You can indicate feeling completely unhappy by filling in the bubble in the figure on the right. The figures also allow you to describe intermediate feelings of pleasure. If you feel completely neutral, neither happy nor unhappy, fill in the bubble in the figure in the middle. If, in your judgment, your feeling of pleasure or displeasure falls *between* two of the figures, then fill in the circle between the figures. This allows you to make more finely graded ratings of how you feel when viewing the pictures.

The excited-versus-calm dimension is the second type of feeling that SAM represents. At one extreme of this scale, you feel stimulated, excited, frenzied, jittery, wide awake, aroused. If you feel completely aroused while viewing the picture, fill in the bubble in the figure at the left of the row. On the other hand, at the other end of the scale, you feel completely relaxed, calm, sluggish, dull, sleepy, unaroused. You can indicate that you feel completely calm by filling in the bubble in the figure at the right. As with the happy-unhappy scale, you can represent intermediate levels by filling in the bubble in any of the other figures. If you are not at all excited nor at all calm, fill in the figure in the middle. Again, if you wish to make a more finely tuned rating of how excited or calm you feel, fill in the circle between any of the pictures.

Acknowledgments

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Please send requests for reprints to either author at: NIMH Center for the Study of Emotion and Attention (CSEA), Box 100165 HSC, University of Florida, Gainesville, FL 32610–0165.

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