Fearfulness and Affective Evaluations of Pictures

Margaret M. Bradley and Peter J. Lang

Subjects high and low in temperamental fearfulness made a speeded decision regarding whether each of a series of affective pictures was "unpleasant" or "pleasant." Fearful subjects made faster decisions on unpleasant pictures than did low fear subjects, whereas no difference was found between low and high fear participants when processing pleasant materials. Reaction time differences as a function of fearfulness were amplified when unpleasant pictures were also high in arousal, suggesting that stimulus intensity is a relevant methodological factor when assessing effects of temperament in cognitive processing. Taken together, these data are consistent with the hypothesis that an anxious or fearful temperament is associated with rapid reactions to unpleasant events.

Current views of temperament and personality are converging on the notion that differences in a factor related to trait anxiety may affect how people respond to emotional events (e.g., Derryberry & Rothbart, 1988; Eysenck, 1992; Watson & Clark, 1984). For instance, Byrne and Eysenck (1995) suggest that individuals high in trait anxiety engage in preferential processing of threatening objects and have a tendency to interpret ambiguous stimuli as threatening. Mathews and Milroy (1994) conclude that evidence generally supports the notion that threatening stimuli capture attention in anxious individuals. Most research investigating effects of trait anxiety on cognitive performance has used word stimuli that are either unpleasant or neutral. In the present study, we investigated the extent to which fearfulness affects cognitive processing by exploring how subjects high or low in temperamental fearfulness perceive emotional—both unpleasant and pleasant—pictures that also varied in level of arousal.

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There are a number of reasons for using emotional pictures as cues to affective experience. First, we have been systematically collecting and acquiring affective norms for a large variety of pictures that vary in pleasure and arousal, which are gathered together in the International Affective Picture System (IAPS) (Center for the Study of Emotion and Attention, 1999). This standardized collection of color photographs (over 600 to date) allows one to easily select and control stimuli based on standard ratings of pleasure and arousal. Use of these stimuli allows us to (1) assess reactions to both unpleasant and pleasant stimuli as a function of temperamental fearfulness and (2) determine whether the level of arousal associated with the stimulus affects differential reactivity.

Secondly, recent studies have demonstrated that these emotional pictures reliably elicit measurable responses in several affect-relevant physiological and behavioral systems, including heart rate, skin conductance, facial muscle responses, and event-related potentials (see Bradley, Greenwald, & Hamm, 1993; Greenwald, Cook, & Lang, 1989; Lang, Greenwald, Bradley, & Hamm, 1993; Bradley & Lang, in press), as well as modulation of both startle and spinal reflexes (e.g., Bonnet, Bradley, Lang, & Requin, 1995; Lang, Bradley, & Cuthbert, 1990). Pictures of affective events and objects are also ecologically valid stimuli in the sense that they involve processing the kinds of visual material that people encounter daily in magazines, newspapers, books, and on television. Moreover, non-lexical visual information is often the first cue to signal a threat in the natural environment (e.g., the sight of a snake in the woods).

To measure trait anxiety or fearfulness, an instrument is needed that distinguishes between people disposed to fearful, anxious states and those who are not. Several existing questionnaires appear to tap this pervasive dimension of personality (see Strelau, 1991, for a representative list). In the current study, we used the EASI temperament questionnaire designed by Buss and Plomin (1975, 1984), as this instrument was designed to measure temperamental traits that are, in large part, inherited. Using data from monozygotic and dizygotic twins to select items, Buss and Plomin (1975) constructed this easy to administer questionnaire, which, in addition to assessing other personality traits, provides a measure of temperamental fearfulness, used here to index trait anxiety.

Each subject was asked to make a speeded decision regarding whether each of a series of 96 pictures denoted something pleasant or unpleasant, and reaction time was measured. Picture stimuli were selected to vary in pleasantness (pleasant, 3 The IAPS (CSEA, 1999) and technical manuals (Lang, Bradley, & Cuthbert, 1999) can be obtained upon request from the authors. IAPS numbers for pictures used in this study were, for unpleasant, low arousal: 9000, 9010, 9090, 9110, 9080, 9290, 9440, 5970, 1230, 1270, 1280, 9180, 2190, 2200, 9070, 2720, 9190, 6010, 8010, 2690, 2230, 2520, 2810, 2700; for unpleasant, high arousal: 6200, 6800, 6940, 9300, 5940, 6910, 9050, 6230, 9500, 1300, 1930, 1120, 2800, 9040, 8230, 9400, 9250, 8480, 3250, 3150, 3130, 3170, 3000, 9410; for pleasant, low arousal: 8510, 5830, 5600, 6520, 6570, 6550, 5940, 4610, 5930, 4640, 4550, 4510, 4210, 8030, 4680.
unpleasant) and in level of arousal (low, high) within each valence category. If trait fearfulness facilitates processing of aversive stimuli, we expected that subjects high in fearfulness would be faster when responding to unpleasant pictures. A negative bias would be evidenced in facilitated performance for aversive stimuli when compared to low fear subjects, or as faster performance for unpleasant, compared to pleasant, pictures within the high fear group, or both types of effects. By manipulating picture arousal (i.e., low, high) within the unpleasant picture category, we were also able to assess the extent to which a factor of stimulus intensity is important in obtaining individual differences due to trait fearfulness or anxiety.

Whereas a bias in processing unpleasant stimuli for high fear subjects was predicted, hypotheses regarding differential processing of affective materials for low fear subjects were not as clearly motivated by existing data or theory. Some data indicate that subjects low in trait anxiety are slower to process unpleasant stimuli (e.g., Mathews & Milroy, 1994) which would suggest that low fear subjects may be faster or more accurate at processing pleasant compared to unpleasant stimuli, or when compared to high fear subjects.

**METHOD**

**Subjects**

Forty right-handed University of Florida introductory psychology students (23 male, 17 female) participated for course credit.

**Materials and Design**

Ninety-six pictures were chosen on the basis of their normative pleasure and arousal ratings (Lang, Bradley, & Cuthbert, 1999) from the IAPS (CSEA, 1999), a collection of standardized, color photographic materials. Figure 1 illustrates the distribution of IAPS pictures in a two-dimensional space defined by the mean pleasure and arousal ratings. Of the 96 pictures, 48 pictures were unpleasant and 48 were pleasant; 24 of each valence were high in arousal and half were lower in arousal. Table I lists the mean pleasure and arousal ratings for each affective category based on the normative ratings in the IAPS (Lang et al., 1999). Pleasant and unpleasant pictures clearly differed in terms of pleasantness and were matched for arousal in both the low and high arousal categories. As Fig. 1 makes clear, whereas it is possible to match valence ratings for pleasant pictures that are low or high in arousal, unpleasant pictures that are relatively low in arousal also tend to be less unpleasant. These facts about the empirical distribution of pictures in affective space are reflected in the mean valence ratings for unpleasant pictures in the low and high arousal categories.
Fig. 1. A plot of over 600 pictures from the IAPS (CSEA, 1999) in a two-dimensional space defined by normative ratings of pleasure and arousal. The pictures in filled squares are those used in the present study and are representative of the natural distribution of pictures in affective space.

Table I. Normative Ratings of Pleasure and Arousal Averaged Across the IAPS Pictures Used in Each of the Affective Categories in the Current Study. Based on Data From Lang, Bradley, & Cuthbert (1999)

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<tr>
<th></th>
<th>Unpleasant Pictures</th>
<th>Pleasant Pictures</th>
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<tr>
<td></td>
<td>High Arousal</td>
<td>Low Arousal</td>
</tr>
<tr>
<td>Pleasure</td>
<td>2.7 (1.1)</td>
<td>3.9 (1.7)</td>
</tr>
<tr>
<td>Arousal</td>
<td>6.4 (1.7)</td>
<td>4.2 (0.6)</td>
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*Pleasure and arousal are rated on a 1 to 9 scale, with 1 low on each dimension and 9 high on each dimension.

SD given in parentheses.

Each IAPS picture has been rated by 80–120 people.
Three semantic categories were also represented, including people (\(n = 48\)), objects (\(n = 32\)), and animals (\(n = 16\)). Within each of these three semantic sets, pictures were equally divided into the four affective categories formed by covarying pleasure and arousal, resulting in 12 pictures of each affective type for people, 8 for objects, and 4 for animals. The pictures were presented in four different orders across subjects, such that each picture occurred equally often in the first or second half of the series, and in the local context of both high and low arousal materials.

**Procedure**

The subject sat in a recliner in a sound-attenuated, dimly lit room. After filling out a consent form, the subject was instructed that a series of pictures would be displayed one at a time, and that the subject should decide as quickly as possible whether each picture depicted something pleasant or unpleasant. Each trial was preceded by a brief warning tone. Two seconds later, a slide was projected on a screen in front of the subject. Two button paddles were held (one in each hand), and the subject pressed one of these buttons as soon as a decision regarding the pleasantness of the picture content was made. Hand of response (left, right) and decision (pleasant, unpleasant) was counterbalanced across subjects. After a short (4 s) inter-trial interval, the next trial began.

Following the 96 picture trials, the subject completed the EASI temperament questionnaire (Buss & Plomin, 1975, 1984), which consists of 25 items (scored on a 1 to 5 Likert Scale) that produce five subscale scores of Fear Emotionality, Anger Emotionality, Activity, Sociability, and Impulsivity. The fear subscale of the EASI measures general feelings of fear and anxiety, rather than fear of specific objects or events, and includes items such as: I am easily frightened; I often feel insecure; When I get scared, I panic. After questionnaire completion, the subject was debriefed, paid, and thanked.

**RESULTS**

**Data Scoring**

Trials resulting in reaction times greater than 4 s (4% of the trials) or on which the subject disagreed with the *a priori* valence designation of the slide were not used in the reaction time analysis. The mean reaction time for each subject was calculated at each level of pleasure (pleasant, unpleasant) and arousal (low, high) for each of the three semantic categories (people, objects, animals). Temperamental groups differing in fearfulness were formed by a median split on the fear subscale (range = 5 to 20), with high fear subjects scoring \(\geq 14\) (\(n = 21\); 10 men, 11 women).
and low fear subjects scoring <14 (n = 19; 13 men, 6 women). A univariate analysis of variance was conducted using a 2 (Fearfulness: High or Low) × 2 (Picture Pleasure: High or Low) × 2 (Picture Arousal: High or Low) × 3 (Semantic Category: People, Objects, Animals) mixed design with mean reaction time as the dependent measure.

Reaction Time

A significant main effect of pleasure \([F(1, 38) = 18.86, p < .001]\) was modified by a significant two-way interaction involving Pleasure and Arousal, \(F(1, 38) = 74.84, p < .001\). For highly arousing pictures—those most typically considered highly emotional—reaction time (RT) decisions did not significantly differ as a function of pleasantness \((F < 1)\), with a mean RT of 1420 ms when deciding a picture was unpleasant, and a mean RT of 1428 ms when deciding a picture was pleasant. On the other hand, less arousing pictures were more difficult to categorize as unpleasant \((mean = 1627\, ms)\), compared to pleasant \((mean = 1294\, ms)\), \(F(1, 38) = 62.26, p < .001\).

Table II lists the mean reaction time in each affective picture category for high and low fear subjects. Temperamental fearfulness significantly affected the pattern of reaction time, as the Fearfulness × Pleasure interaction demonstrated,

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<tr>
<td></td>
<td>High Arousal</td>
<td>Low Arousal</td>
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<tr>
<td>High fear</td>
<td></td>
<td></td>
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<tr>
<td>1219</td>
<td>(427)</td>
<td>1500</td>
</tr>
<tr>
<td>Low fear</td>
<td></td>
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<tr>
<td>1644</td>
<td>(476)</td>
<td>1767</td>
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<th></th>
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<th>Pleasant Pictures</th>
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<tbody>
<tr>
<td></td>
<td>High Arousal</td>
<td>Low Arousal</td>
</tr>
<tr>
<td>High fear</td>
<td>.95</td>
<td>.77</td>
</tr>
<tr>
<td>(0.04)</td>
<td>(0.12)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Low fear</td>
<td>.89</td>
<td>.73</td>
</tr>
<tr>
<td>(0.09)</td>
<td>(0.11)</td>
<td>(0.06)</td>
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</table>

*SD given in parentheses.
Fearful subjects responded faster to unpleasant pictures than subjects low in fear, $F(1, 38) = 7.62, p < .01$. High fear subjects also responded faster than low fear subjects to pleasant pictures, $F(1, 38) = 5.20, p < .03$, whereas high and low fear subjects did not significantly differ in the speed of responses to pleasant pictures. Furthermore, a significant 3-way interaction involving Fearfulness, Pleasure, and Arousal, $F(1, 38) = 7.06, p < .01$, indicated that level of arousal played a role as well. Followup analyses assessed the relationship between fearfulness and pleasure for low and high arousal materials separately. For low arousal pictures, this analysis indicated only that unpleasant pictures were responded to more slowly than pleasant pictures: There were no differences as a function of fearfulness. For high arousal pictures, however, a significant Fearfulness $\times$ Pleasure interaction, $F(1, 38) = 12.92, p = .001$, indicated that high fear subjects made faster decisions than low fear subjects on unpleasant, $F(1, 38) = 8.92, p = .005$, but not pleasant pictures, $F < 1$.

The relationship between Fearfulness, Pleasure, and Arousal can also be illuminated by assessing the pattern of effects within each temperament group. For low arousal pictures, each group was significantly slower for unpleasant, compared to pleasant, pictures [for high fear subjects: $F(1, 18) = 27.55, p < .001$; for low fear subjects: $F(1, 20) = 39.03, p < .001$]. For highly arousing pictures, on the other hand, the pattern of performance was different as a function of temperament. High fear subjects were significantly faster when responding to arousing, aversive pictures (mean = 1219), compared to when they responded to pleasant pictures high in arousal (mean = 1377; $F(1, 20) = 14.19, p < .001$). Reaction time for high fear subjects, on the other hand, was not significantly different as a function of picture valence. Taken together, these data indicate that highly fearful subjects responded most rapidly to unpleasant pictures that were also highly arousing.

A number of significant effects involving semantic category were also obtained [i.e., Category, $F(2, 76) = 9.11$; Category $\times$ Arousal, $F(2, 76) = 8.61$; Category $\times$ Pleasure $\times$ Arousal, $F(2, 76) = 5.83$], and Table III lists the reaction times.
Fig. 2. Reaction time performance for unpleasant, arousing pictures demonstrates that fearful subjects respond more quickly when deciding the picture is unpleasant, compared to low fear subjects.

time data as a function of semantic category, pleasure, and arousal.⁴ There were no significant effects involving Category and Fearfulness, however, indicating that the bias to respond rapidly to unpleasant pictures for high fearful subjects was similar across the three semantic categories of people, animals, and objects. Figure 2 presents RTs for highly arousing, unpleasant pictures in each of the three semantic categories for participants high and low in fearfulness, which makes clear that this effect is consistent across the three semantic categories used here.

Median splits were also conducted on the other four temperamental traits that the EASI measures (i.e., Anger, Sociability, Activity, and Impulsivity). No

⁴Response times for making "pleasant" or "unpleasant" decisions seemed to be rather slow, at least when compared to cognitive tasks involving words. Presumably, part of this time is necessary to simply encode the picture content. To determine how quickly evaluative decisions can be made by people very familiar with the picture contents, 7 members of our laboratory, all of whom deal with the IAPS pictures on a daily basis, were run in the same paradigm. For this group, mean RTs for highly arousing pictures were 733 ms for unpleasant and 782 ms for pleasant pictures, respectively. For the low arousal pictures, RTs were 827 ms and 789 ms for unpleasant and pleasant pictures, respectively. Thus, when the pictures are quite familiar, RTs are considerably shorter, but are still somewhat lengthy, compared to many word tasks. Thus, familiarity reduced evaluation times by almost half, suggesting that these complex pictures require time for simply recognizing the perceptual information.
significant effects involving these traits and picture pleasure or arousal were obtained in reaction time, except for the Activity scale which produced a significant interaction of Pleasure × Temperament, $F(1, 38) = 5.43, p = .03$. The correlation of scores on the Fear and Activity scales was $- .46$ in this sample, however; and when both factors were included in a stepwise regression analysis of reaction time for unpleasant, arousing pictures, only the Fearfulness factor accounted for a significant portion of the variance.

**Agreement With A Priori Valence**

The effects obtained in the RT data could indicate a bias toward responding to one type of material or another or could simply reflect a speed-accuracy tradeoff in which participants were faster for some affective category but also made more errors. Thus, we analyzed the proportion of trials that subjects agreed with the a priori category of the picture (i.e., a type of accuracy judgment) to assess whether significant patterns of RT were associated with higher error rates.

In general, subjects' agreement with the a priori valence category of the pictures was high (mean = .88). As found in RT, significant effects were obtained for Pleasure [$F(1, 38) = 19.47, p < .001$], Arousal [$F(1, 38) = 12.76, p < .01$], and their interaction [$F(1, 38) = 54.38, p < .001$]. Consistent with the generally slow reaction times found for pictures that were unpleasant and low in arousal, these pictures were also the hardest for subjects to categorize (mean accuracy = .75), with performance for these materials significantly lower than for any of the other picture contents (mean = .92, .95, and .90 for unpleasant pictures of high arousal, and pleasant pictures of low and high arousal, respectively). When confining attention to the highly arousing (emotional) materials, however, there was no significant difference in agreement between pleasant and unpleasant materials, similar to the pattern obtained in the RT data ($F < 1$).

These data were also assessed for each of the significant interactions obtained in the RT data that involved fearfulness. Similar to the pattern obtained in the reaction time data, highly fearful subjects showed more (not less) agreement with the a priori categorization and labeled aversive pictures as unpleasant more frequently than low fear subjects, $F(1, 38) = 4.86, p = .03$, whereas there was no difference in performance on pleasant pictures between the two groups ($F < 1$). When analysis was confined to the highly arousing picture categories, highly fearful subjects again showed significantly more (not less) agreement in labeling aversive pictures as unpleasant, compared to performance for pleasant materials, interaction $F(1, 38) = 5.56, p = .02$. Agreement for highly arousing unpleasant pictures in the fearful subjects (mean = .95) was higher than for low fear subjects (mean = .89), $F(1, 38) = 5.07, p = .03$, whereas performance was not significantly different between the two groups for arousing pleasant materials ($F < 1$; means = .88 and
DISCUSSION

People with a fearful temperament were significantly faster when classifying aversive pictures as unpleasant, compared to those low in fearfulness. This facilitation in performance occurred regardless of whether the pictures depicted unpleasant people, animals, or objects. These data suggest that a temperamental disposition toward fearfulness is associated with a broad disposition to rapidly discriminate aversive events, as it was evidenced here as a general facilitation in categorizing pictures as unpleasant across a wide variety of aversive contents. On the other hand, for pleasant pictures, the high and low fear groups showed no differences in speed of evaluation, with equally rapid responses to a variety of different pictures depicting scenes involving pleasant people, animals, and objects.

Whereas highly fearful subjects were generally faster than low fear subjects when categorizing unpleasant pictures, the effect was even more pronounced for unpleasant pictures that were also high in arousal—those usually considered the most emotionally evocative (i.e., pictures of mutilated bodies, attacking animals, etc.). High fear subjects were significantly faster responding to highly arousing unpleasant, compared to pleasant, pictures, whereas there was no significant difference in reaction time between these pictures for the low fear subjects. These data are consistent with other data from our laboratory that indicate that stimulus arousal plays an important role in modulating emotional reactions (e.g., Lang, Bradley, & Cuthbert, 1997, for an overview). Using highly arousing stimuli, or manipulating the level of arousal within each valence category, may be important when investigating effects of trait anxiety on cognitive performance.

The hypothesis that high trait anxious people show selective biases in the processing of emotional information has been investigated recently in both clinical and non-clinical (see Dalgleish & Watts, 1990; Mineka & Sutton, 1992) populations. Much of this research uses affective words in the context of cognitive tasks such as the Stroop or the dot-probe paradigm (see Dombek & Ingram, 1993, for an overview), in which performance is assumed to reflect attentional allocation to anxiety-related stimuli. Although the findings from these studies are not always consistent, taken together they suggest that anxious persons show attentional biases (i.e., are vigilant to stimuli) specific to their personal concerns, rather than showing a general bias for all unpleasant stimuli, as found in the current study.

The processing task used here differs from a number of previous studies both in the materials that were used (i.e., pictures) and in requiring an evaluative response regarding stimulus valence. The difference in materials is less likely to be critical, as a number of recent studies have used picture stimuli such as emotional faces or phobic objects (e.g., Winton, Clark, & Edelmann, 1995; Byrne & Eysenck,
A more likely hypothesis is that the difference is related to the evaluative nature of the task. Deciding whether a stimulus connotes something good or bad taps evaluative, in addition to attentional, processes, which could lead to the general bias found here.

One possibility is that highly fearful subjects are either more likely or more willing to categorize an input as threatening (or unpleasant) than low fear subjects. That is, fearfulness may be associated with a tendency for a person to be over-inclusive, seeing more things in the world as bad. A threshold hypothesis such as this would predict the pattern obtained here for high fear subjects: faster performance and higher agreement with the a priori valence category, specifically for unpleasant stimuli. On the other hand, a threshold hypothesis would also tend to predict some type of performance decrement on pleasant stimuli in this group, as a low threshold for responding ‘unpleasant’ should impact on other decisions as well (i.e., increase errors). The lack of group differences in responding to pleasant stimuli is not consistent with the notion that fearful subjects tend to over-include because of a lower threshold.

A processing account of the current results, on the other hand, interprets these data as resulting from a facilitation in perceiving and recognizing unpleasant pictures, which predicts better and faster performance for unpleasant pictures, and no difference between the groups for pleasant pictures. This, in fact, is the pattern obtained here. Thus, these data suggest that the bias in information processing for high fear subjects probably results from efficient processing of unpleasant materials, rather than an impairment in processing positive information, or some combination of the two. In addition, low fear subjects responded equally quickly to both pleasant and unpleasant arousing pictures, suggesting there is no bias toward processing positive events when fearfulness is low.

The speed of valence decisions was primarily modulated by trait fearfulness. The EASI temperament questionnaire provides an index of a number of other heritable traits, including anger, sociability, activity, and impulsivity, and yet none of these traits reliably affected the pattern of reaction time performance. In particular, the lack of an association between the anger scale and performance suggests that a more general trait of negative affect (e.g., Watson & Tellegen, 1985) is probably not responsible for the pattern of reaction times obtained here, as negative affect is presumed to be related to a range of negative traits such as anger, sadness, and depression as well as fear and anxiety (e.g., Watson, Clark, & Mineka, 1994). Clearly, however, it will be important to re-assess the relationships found in the current study with other questionnaire measures of negative affect as well as trait anxiety.

All participants were slowest when evaluating unpleasant pictures that were low in arousal and showed the lowest level of agreement with the a priori category for these pictures. Unpleasant arousing stimuli are rated as more unpleasant than those that are low in arousal (see Table I), with the unpleasant, calm pictures tending more toward neutral in their valence ratings. Figure 1 is a plot of the 600 pictures
currently in the International Affective Picture System (CSEA, 1998) in the 2-dimensional space defined by each picture’s mean valence and arousal rating. A large number of equally pleasant pictures occur in both the calm and arousing quadrants of this affective space, consistent with the mean valence ratings for the pictures used in the current study (see Table I).

On the other hand, the lower left-hand quadrant, which includes pictures rated as unpleasant and relatively calm contains fewer exemplars than those that are unpleasant and arousing (lower right-hand quadrant) and they are rated as less unpleasant as well. The slow RT decisions suggest it was difficult to decide whether these stimuli were negative enough to be categorized as unpleasant. From a motivational perspective (e.g., Lang, Bradley, & Cuthbert, 1990, 1997), one interpretation is that, in the natural world, unpleasant events prompt intense mobilization, as when a stimulus involves a direct threat to the organism. When an unpleasant event does not arouse, it is simply not as aversive as well. On the other hand, humans at least appear to be able to find high pleasure in flowers, clouds, and the other types of appetitive stimuli that are typically rated as low in arousal. In any case, the empirical shape of affective space makes it impossible to exactly match valence ratings for unpleasant pictures that are low and high in arousal: The affective world is not built this way.

The present results show that the evaluative judgment of pictures can be a useful task in assessing the effects of emotionality on performance. Furthermore, they contribute to a growing data base indicating that trait emotionality may be a basic component modulating human information processing.

REFERENCES


