Watch Out! That Could Be Dangerous: Valence-Arousal Interactions in Evaluative Processing

Michael D. Robinson
North Dakota State University
Justin Storbeck
University of Virginia
Brian P. Meier
Ben S. Kirkeby
North Dakota State University

Seven studies involving 146 undergraduates examined the effects of stimulus valence and arousal on direct and indirect measures of evaluative processing. Stimuli were emotional slides (Studies 1 to 6) or words (Study 7) that systematically varied in valence and arousal. Evaluative categorization was measured by reaction times to evaluate the stimuli (Studies 2, 3, and 7), latencies related to emotional feelings (Study 3), and incidental effects on motor performance (Studies 4 and 5). A consistent interaction was observed such that evaluation latencies were faster if a negative stimulus was high in arousal or if a positive stimulus was low in arousal. Studies 1, 6, and 7 establish that the findings are not due to stimulus identification processes. The findings therefore suggest that people make evaluative inferences on the basis of stimulus arousal.

Keywords: *affect; appraisal; cognition; valence; arousal; emotion*

Valence and arousal are the most important dimensions of connotative meaning (e.g., Osgood, 1969), feeling states (e.g., Russell & Barrett, 1999), and emotion-related behavior (e.g., Lang, 1995). However, there are some divergent theoretical proposals related to the question of how valence and arousal might interact in determining these outcomes. Some scholars, such as Watson (Watson, Wiese, Vaidya, & Tellegen, 1999) and Lang (1995), propose that arousal is not truly independent of valence. Rather, arousal can either be of the negative variety, reflecting the activation of an avoidance system, or of the positive variety, reflecting the activation of an approach system. Other theorists argue that valence and arousal are largely independent in their effects on experience (Russell & Barrett, 1999), physiology (Lang, Greenwald, Bradley, & Hamm, 1993), and brain activity (Heller & Nitschke, 1998), and therefore should be considered as orthogonal dimensions of appraisal and emotion.

What is common to multiple theories, however, is the assumed independence of valence and arousal. And indeed, there are dependent measures, such as self-reported emotional experience, that favor the independence of the dimensions. However, this independence need not be true when examining initial stages of stimulus appraisal. This is particularly true given some evidence that during initial stages of encoding, arousing objects are presumed to be potentially dangerous, whereas nonarousing objects are presumed to be safe.

In this connection, Schneirla (1959) attempted to characterize emotional valence and arousal as they apply to lower animals, such as the ant and the paramecium. He suggested that approach and avoidance behaviors seem to be governed by a curvilinear relationship relating emotional arousal to emotional valence. At moderate levels of intensity, approach is facilitated. At higher

Authors' Note: Grant support is acknowledged from the National Science Foundation (9817649) and the National Institute of Mental Health (068241). Correspondence should be addressed to Michael Robinson, Psychology Department, North Dakota State University, Fargo, ND 58105; e-mail: Michael.D.Robinson@ndsu.nodak.edu.

PSPB, Vol. 30 No. 11, November 2004 1472-1484
DOI: 10.1177/0146167204266647

levels of intensity, by contrast, avoidance is facilitated. For example, a paramecium will approach a light of a moderate intensity but will avoid a light of high intensity (Schneirla, 1959). Among human infants, a similar pattern may apply (Izard, 1993). Research and theory in fact suggests that the ability to regulate intense stimulation develops early in childhood, specifically with the maturation of the prefrontal cortex (Harman & Fox, 1997). Because infants are unable to regulate intense stimulation, an intense stimulus tends to overwhelm the attentional and coping abilities of the infant, leading to apparent distress and avoidance (Harman & Fox, 1997; Rothbart, Posner, & Boylan, 1990).

Valence-arousal interactions of the type mentioned above are probably not unique to lower animals and human infants. To understand why this is true, it is useful to appreciate the fact that there may be two distinct preattentive mechanisms related to emotional appraisal (Robinson, 1998).

Preattentive Mechanisms in Emotional Appraisal

A good deal of evidence suggests that people automatically evaluate stimuli, at least under certain task conditions (Klauer & Musch, 2003). Such evidence has come from latency- (e.g., Bargh, Chaiken, Govender, & Pratto, 1992) and judgment-based (e.g., Murphy & Zajonc, 1993) versions of the affective priming paradigm. It also has come from other paradigms such as the emotional Stroop task (e.g., Pratto, 1994), the affective Simon task (e.g., De Houwer & Eelen, 1998), and the implicit association test (e.g., Greenwald, McGhee, & Schwartz, 1998). The valence of an object can be decoded quickly, a point that is apparent in findings showing that subliminal presentations of valenced stimuli are effective in altering evaluations (Dijksterhuis & Aarts, 2003; Murphy & Zajonc, 1993).

However, there is also evidence for a second mechanism that orients attention toward novel and intense stimuli. Reliable output from this mechanism include skin conductance responses, a decrease in heart rate (for visual stimuli), and enhanced attention (Lang, Bradley, & Cuthbert, 1997). Stimulus intensity can be coded preattentively, as established by a large body of findings showing that subliminal stimuli are capable of eliciting the orienting response (Öhman, 1997). Although at the conscious level orienting occurs for both positive and negative stimuli (Lang et al., 1997), there is a reason to think that, at the preattentive level, the orienting response may be associated with the fear system (Öhman, 1997; Robinson, 1998). Of interest, however, its inputs are not specific to threatening stimuli (e.g., snakes, anger faces). Rather, it may respond to a broader range of inputs that are indicative of potential danger, such as intensity and capacity of quick motion. In the words of Öhman (1997), preattentive aspects of orienting "are determined by simple stimulus dimensions such as sudden onset or high intensity. . . . Abrupt, high-intensity stimulation has been associated with danger throughout evolution, and therefore sensory systems have tuned immediately and automatically to respond to such stimulus parameters" (p. 167).

An implication of this view is that arousing stimuli, regardless of whether they are positive or negative, may trigger preattentive aspects of orienting and in turn be associated with preattentive evaluations indicative of potential danger. For example, a roller coaster ride, which is enjoyable for many who ride it, may nevertheless be automatically evaluated as negative based on its intensity and capacity for quick motion.

From Independence to Integration

On one hand, positive stimuli induce an approach orientation, whereas negative stimuli induce an avoidance orientation (Neumann, Förster, & Strack, 2003). On the other hand, intense and novel stimuli trigger an avoidance orientation, whereas mild and familiar stimuli trigger an approach orientation (Zajonc, 2001). According to Robinson (1998), both of these computations are performed independently at the preattentive level. However, Robinson also proposed that these two mechanisms contribute to one's conscious understanding of the stimulus. That is, output from the two mechanisms must be integrated prior to conscious evaluation.

Because intense stimuli are potentially dangerous ones, this integrative activity may be easier when a stimulus is both negative and high in arousal. For example, a stimulus such as a scowling, barking dog, which is both negative and arousing, is clearly a potential threat to the self. Such a stimulus should be evaluated quickly at the conscious level. By contrast, a stimulus such as an injured kitten might be more difficult to evaluate. On one hand, the sight of a helpless animal engenders some pity and approach motivation; on the other hand, the injury provokes negative affect in the viewer. The combination may result in a conflicted state in which both approach and avoidance motives are present (Lang, 1995).

By contrast, evaluative decisions may be slowed when a stimulus is both positive and arousing. The intense aspect of the stimulus may promote a certain defensive orientation until the stimulus is better understood. And yet, the positive affective nature of the stimulus precludes making a negative evaluation. The result should be considerable uncertainty as to whether the stimulus is beneficial or harmful during early stages of stimulus encoding. For example, there are few acts that bring more pleasure than sex. And yet, we do not expect to see attractive naked strangers in our living room, and we are not immediately prepared to cope with such opportunities. By contrast, a positive low arousal stimulus such as a piece of chocolate cake brings pleasure but no immediate hint of danger or uncertainty. In this case, a preattentive evaluation of the stimulus as positive would have no competition from a second preattentive mechanism devoted to intensity or arousal. If these speculations are correct, valence and arousal may interact in determining conscious evaluation speed. These ideas motivated the present studies.

Overview of Studies

Stimuli for most of the studies consisted of slides from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999). To study direct aspects of evaluative processing, we simply asked people to, as quickly and accurately as possible, categorize stimuli as positive or negative in three separate studies (Studies 2, 3, and 7). Because we hypothesized that emotional arousal is negatively coded, we expected valence and arousal to interact such that negative/high arousal and positive/low arousal stimuli would be evaluated more quickly.

In two additional studies (Studies 4 and 5), we asked people to evaluate the slides covertly and then perform a second task. When two tasks are closely sequenced in time, performance on the second task is dependent on resolution of the first task, as known in the attention and performance literature (Pashler, Johnston, & Ruthruff, 2000). We expected to observe a similar Valence × Arousal interaction in these studies. Of importance, because stimulus and response factors were independently varied in Studies 4 and 5, interactions must be interpreted in terms of encoding operations rather than response factors.

Because Studies 1 through 6 all used emotional slides as stimuli, it seemed possible that valence/arousal interactions could be specific to pictorial images. To broaden the scope of the current framework, we sought to replicate key results in Study 7, this time in the context of stimulus words rather than images.

STUDY 1

Prior to conducting Studies 2 through 7, we conducted Study 1, which was concerned with stimulus selection issues. We sought to select emotional slides that were independent in valence and arousal. In addition, Study 1 sought to show that there is no Valence × Arousal interaction related to the visual complexity of the slides. To the extent that there is not, subsequent findings can be interpreted in terms of evaluative processing specifically rather than object identification processes more generally. The identification norms collected in Study 1 also were examined in Study 6 reported later in the article.

Method

Participants. Participants were 20 undergraduates from the University of Illinois who received course credit.

Apparatus. A DOS-based computer controlled two Kodak Ektapro projectors. The projectors were designed to interface with a computer and be capable of randomized presentation sequences. Projectors were placed within a handmade case that rested on top of a 5-ft filing cabinet that projected images from behind and above the participant during the course of the study. Precise timing was accomplished by using high-speed Uniblitz shutters affixed to the projector lenses (approximately 1 ms random error).

Participants sat in a standard chair equipped with a small desk. The chair was placed 3 ft in front of a large (5 ft × 5 ft) projection screen. Emotional images were approximately 3 ft × 3 ft and were projected onto the center of the screen. The environment was immersive in that images were typically life sized or larger.

Stimuli. Emotional slides were chosen from Lang et al.'s (1999) IAPS. We were particularly interested in choosing slides to represent all cells of a 2 (valence) × 2 (arousal) design. After some preliminary testing (e.g., Robinson & Clore, 2001), we settled on a set of 56 slides. Twenty-eight of them were negative in valence, whereas 28 were positive. Within each valence, there were 14 low arousal and 14 high arousal slides.[1]

It is useful to statistically establish that valence and arousal were manipulated independently in the present design. To establish this point, we created a data set with slide as unit of analysis ($N = 56$). We then entered dummy codes for our dichotomized valence (positive vs. negative) and arousal (low vs. high) factors. We then added valence and arousal means from Lang et al.'s (1999) slide norms. Finally, we computed a valence extremity score for each slide, which was defined in terms of the extent to which Lang et al.'s valence mean for the slide differed from 5.0, the midpoint of their scale.

A series of one-way ANOVAs established that our valence designation of slides was a strong predictor of Lang et al.'s (1999) valence norms, $F(1, 54) = 715.47$, $p = .00$, but did not predict arousal norms, $F(1, 54) = 1.36$, $p = .25$, or valence extremity scores, $F(1, 54) = 2.27$, $p = .14$. A second series of one-way ANOVAs established that our arousal designation of slides was a strong predictor of Lang et al.'s (1999) arousal norms, $F(1, 54) = 186.15$, $p = .00$, but did not predict valence norms, $F < 1$, or valence extremity scores, $F(1, 54) = 1.97$, $p = .17$. Finally, in a third series of 2 (dichotomized valence) × 2 (dichotomized arousal) ANOVAs, we confirmed that dichotomized valence and dichotomized arousal did not interact in predicting Lang et al.'s (1999) valence norms, F(1,

52) = 2.03, p = .16, arousal norms, F(1, 52) = 1.42, p = .24, or valence extremity scores, F(1, 52) = 1.08, p = .30. Valence and arousal were therefore manipulated independently in the stimulus materials.

Procedures. Participants were tested within individual testing sessions. Following a 10-min dark adaptation period, they engaged in the main part of the study. Participants were told that we were interested in how long it would take them to identify the main theme of slides. They were instructed to respond to "gist" information. Specifically, we stated, "If you see a dog, you should hit the spacebar before you know exactly whether the dog is a golden retriever or a German shepherd." These instructions were designed to preclude extensive and identification-irrelevant examination of the slides. There was a 3-s delay between trials and identification responses were made by hitting the spacebar on a computer keyboard.

Results

Prior to analyzing identification times, we log-transformed them to normalize the distribution. We then replaced outliers that were 2.5 standard deviations below or above the grand latency mean with these cutoff scores. Latency means were analyzed in a 2 (valence) × 2 (arousal) repeated-measures ANOVA. There was no effect for valence on identification times, F(1, 19) = 1.14, p = .30. There was, however, a main effect for arousal, F(1, 19) = 8.19, p = .01. The theme of high arousal slides was identified faster (M = 1,046 ms) than the theme of low arousal slides (M = 1,152 ms). This result could be somewhat consistent with the finding that high arousal slides trigger more active processing within the visual cortex (Lang et al., 1998). Of more importance, however, the interaction between valence and arousal was not significant, F < 1. Because the interaction was not significant, interactive effects of valence and arousal cannot be viewed as consequences of visual complexity.

STUDY 2

In Study 1, we showed that the present slides were not associated with a Valence × Arousal interaction on identification latencies. In Study 2, we sought to show that the same slides produce a Valence × Arousal interaction pertaining to evaluation latencies.

Method

Participants. Participants were 21 undergraduates from the University of Illinois who received course credit.

Stimuli and apparatus. The stimuli were the same as in Study 1. The hardware for the study was also very similar

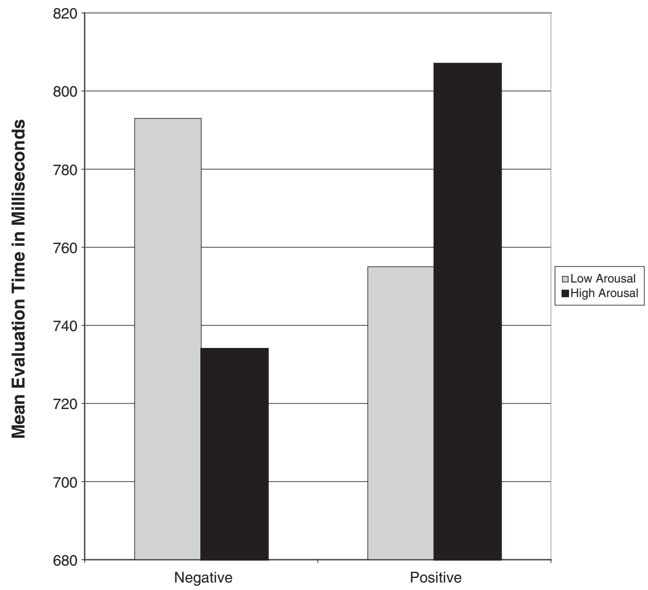

Figure 1 Evaluation latencies by valence and arousal, Study 2.

except that Study 2 used a response box rather than a computer keyboard.

Procedures. After dark adaptation, participants were asked to evaluate the slides as quickly and accurately as possible, indicating whether each slide is positive (1 key; left index finger) or negative (4 key; right index finger). Slides were shown twice, each time in a different random order.[2]

Results

Inaccurate trials were dropped and times were log-transformed. We then replaced times 2.5 standard deviations below and above the grand latency mean with these cutoff scores. Evaluation latencies were analyzed in a 2 (valence) × 2 (arousal) repeated-measures ANOVA. Neither the main effect for valence, F < 1, nor the main effect for arousal, F < 1, was significant. As hypothesized, however, there was a Valence × Arousal interaction, F(1, 20) = 19.75, p = .00. The means, reported in Figure 1, reveal that negative images were evaluated more quickly when high in arousal, whereas positive images were evaluated more quickly when low in arousal.[3]

Discussion

Although Study 1 indicated no hint of a Valence × Arousal interaction influencing identification processes, Study 2 shows that there is a rather robust Valence × Arousal interaction influencing evaluation processes. The latter result provides support for the valence-arousal conflict theory pursued in this article.

At this point, it is worth considering and rejecting an alternative account of Study 2 results. Specifically, it might be proposed that people seek to maximize their exposure to positive events and minimize their exposure to negative events. As a result, they may be reluctant to terminate a positive image by making an evaluation, resulting in slower evaluation times. However, this potential account of our results is flawed for at least three reasons. One, such an explanation for the findings fails to account for the lack of an interaction in Study 1. Two, it fails to explain previous data showing that when participants are given freedom to look at a slide for as short or as long as desirable, it is the arousal level of the stimulus, rather than its valence, that influences viewing time (Lang et al., 1997). Three, this account could predict a valence main effect, but not the Valence × Arousal interaction reported in Study 2. In Study 3, we sought to replicate and extend Study 2.

STUDY 3

Method

Participants. Participants were 20 undergraduates from the University of Illinois who received course credit.

Stimuli and apparatus. Emotional stimuli and apparatus were the same as those reported in Study 2. To represent the task pertaining to a particular block, a second slide projector displayed the slide "evaluate" or "experience" during the relevant trials.

Procedures. Participants were informed that they would (a) evaluate slides, judging whether they were good or bad, and (b) indicate whether the slide causes more pleasant or unpleasant feelings. To make the tasks seem somewhat distinct, we informed participants that evaluation is primarily based on stimulus qualities rather than experience, whereas feelings are primarily based on experience rather than on stimulus qualities. Each slide was paired with each task exactly once. Trials were blocked such that participants performed each task for 10 trials in a row.

When participants were ready to make a judgment, they pressed the 1 key on the response box. When the 1 key was pressed, the emotional slide was removed and the participants pressed the 2 key ("bad" or "unpleasant feelings") or the 3 key ("good" or "pleasant feelings") to make their ratings. Under these procedures, time to press the 1 key becomes the important index of judgment time (see Robinson & Clore, 2002). This said, effects were comparable when latency to press the 1 key was added to latency to make the rating.

Results

As expected, no factors influenced time to press the 2 or 3 key, $ps > .15$. We therefore focused on time to press the 1 key. As in prior studies, we deleted inaccurate trials, log-transformed latencies, and replaced ones that were 2.5 standard deviations above or below the mean. Latency means were examined in a 2 (valence: positive vs. negative) × 2 (arousal: low vs. high) × 2 (judgment: evaluation vs. feeling) ANOVA.

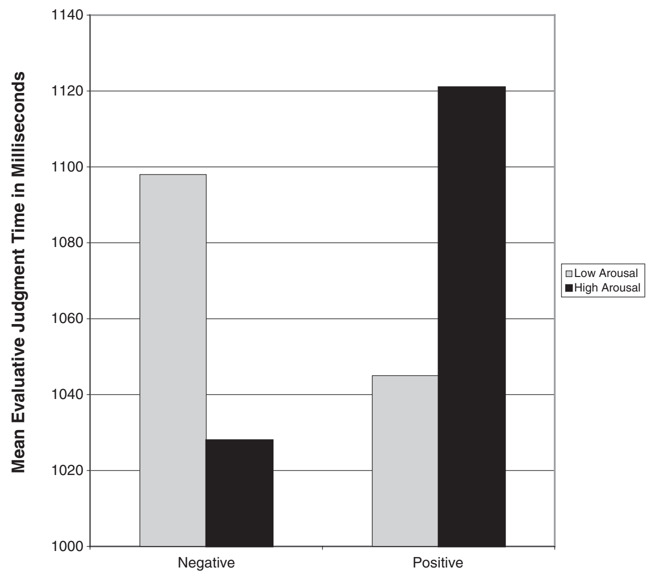

Figure 2 **Evaluative judgment latencies by valence and arousal, Study 3.**

None of the main effects were significant, $Fs < 1$. Also, the three-way Valence × Arousal × Judgment interaction was not significant, $F(1, 19) = 1.50$, $p = .24$, indicating that similar findings pertained to the evaluation task as pertained to the feeling judgment task. Two-way Valence × Judgment, $F(1, 19) = 2.26$, $p = .15$, and Arousal × Judgment, $F < 1$, interactions were similarly not significant. However, as expected, there was a significant Valence × Arousal interaction, $F(1, 19) = 13.86$, $p = .00$, which also was replicated within the evaluation task, $F(1, 19) = 4.43$, $p = .05$, and the feeling judgment task, $F(1, 19) = 17.00$, $p = .00$, considered separately. Figure 2, which reports means collapsed across task, indicates that the Valence × Arousal interaction was parallel to that reported in Study 2.[4]

Discussion

A potential concern with Studies 2 and 3 is that people may hesitate to evaluate positive stimuli as positive if they produce states related to lust, excitement, or joy. Although such states are not socially undesirable in any fundamental way, they may be seen as instrumentally undesirable in that they are perceived as interfering with performance efficiency within everyday life tasks (Erber & Erber, 2000). To the extent that this is true, the individual may choose to recognize and report such states only when they are undeniable. Although we do not feel that such response-related explanations for our findings are legitimate, we also recognize that every public evaluation carries some potential for scrutiny from others.

If so, it seems desirable to show that the same Valence × Arousal interaction characterizes performance on tasks in which there is no public evaluation at all. To this end, we designed Studies 4 and 5 to examine the incidental consequences of evaluation. Participants were asked to evaluate the slides, ostensibly in preparation for later questions. Following each slide, they also engaged in a second, neutral task. If evaluations are delayed because the participant is encountering difficulty in deciding whether a slide is positive or negative, such evaluative difficulties should be reflected in secondary task performance (Pashler et al., 2000). On the basis of this reasoning, we hypothesized that latencies on a neutral secondary task would exhibit a similar Valence × Arousal interaction as obtained in prior studies.

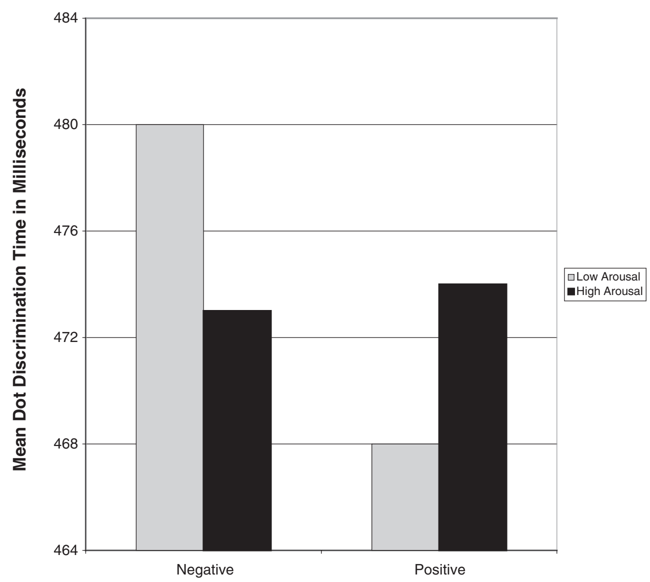

Figure 3 **Dot discrimination latencies by valence and arousal, Study 4.**

STUDY 4

Method

Participants. Participants were 42 undergraduates from North Dakota State University.

Stimuli and apparatus. The emotional stimuli and apparatus were the same as used in Study 2. A second slide projector was equipped to display dot stimuli requiring a response.

Procedures. Participants were told that they had two primary tasks. First, they should attend to and evaluate emotional slides that were presented at the start of each trial because they may be asked about the slides later in the study. Second, they were instructed to determine, as quickly and accurately as possible, whether one or two dots were presented following each emotional slide. This dot discrimination task provided the latency data for the study.

The 56 slides were shown twice each, each time in a different random sequence. Target slides consisted of one or two dots presented to either the left or right visual field. Dot slides were presented laterally at a distance of approximately 2.5 degrees visual angle left or right of fixation. Dot slides were randomly paired with emotional slides.

Each trial had the following sequence. First, a randomly selected emotional slide was presented for 1 s. Second, the slide disappeared followed by a 500 ms blank interval. Third, a laser fixation was presented for 200 ms. Fourth, a dot slide was presented 800 ms following the offset of the laser fixation. Dot slides were presented for 100 ms, a procedure that ensures lateralized presentation (see Robinson & Compton, 2004, for related studies). Fifth and finally, the trial ended when the participant pressed the 1 key on the button box if one dot was presented or hit the 2 key on the button box if two dots were presented. Following this response, there was a 5 s interval before the next trial began.

Results

Inaccurate responses were deleted and times were log-transformed. Subsequently, we replaced latencies 2.5 standard deviations above and below the grand mean with these cutoff values. Means were computed for each cell of the 2 (valence of prime: positive vs. negative) × 2 (arousal of prime: low vs. high) × 2 (visual field: left vs. right) design. Means were then analyzed in a repeated-measures ANOVA. All effects were not significant, ps > .10, except for one. Specifically, the Valence × Arousal interaction was significant, $F(1, 41) = 10.01$, $p = .00$. As Figure 3 shows, the interaction replicates those reported in the prior studies, but does so within the context of an incidental evaluation paradigm.

Discussion

The findings from Study 4 add to our confidence in the valence-arousal conflict theory. When an environmental stimulus is arousing, it is apparently judged, preattentively, to be potentially threatening. This facilitates negative evaluations but inhibits positive evaluations. Although such a conflict is eventually resolved, such a resolution takes time, therefore slowing concurrent performance. Study 5 sought to replicate Study 4, again using an incidental evaluation paradigm. However, we replaced the dot discrimination task with a motor task.

STUDY 5

Method

Participants. Participants were 15 undergraduates from the University of Illinois.

Stimuli and apparatus. Stimuli were the same 56 emotional slides used in prior studies. Hardware for the study was also the same, including the Ektapro projector and the custom-made button box. However, the participant sat in a chair without a desk portion. In addition, the chair was placed closer to the slide screen so that participants could easily reach it. Finally, the button box was affixed to the slide screen such that its location was in the middle, both horizontally and vertically, of projected images.

Procedures. Participants were informed that there were two tasks. One, they should evaluate the emotional slides as they were presented. And two, they should perform an indicated movement as quickly as possible upon a signal from the laser pen. During half of the blocks, participants began each trial with their right hands on their right knees. With a signal from a laser pen, they were instructed to reach up as quickly as possible and press any of the four keys on the button box. During the other half of the blocks, participants began each trial with their index fingers depressing the 1 key of the button box. With a signal from a laser pen, they were instructed to remove their fingers from the button as quickly as possible.

Emotional slides were shown twice each, each time in a different random order. Movement direction—press or release—was randomly paired with slides. Trials were blocked such that participants performed the same movement for seven trials in a row. Trials consisted of the following sequence. First, a picture appeared. Second, there was a 2-s delay until a laser pen fired a 150-ms signal. This signal was the impetus for performing the movement. Third, the participant performed the relevant action.

Results

Movement times were log-transformed to normalize the distribution. For each movement separately, we replaced scores that were 2.5 standard deviations from the grand latency mean for that movement direction. Latency means were examined in a 2 (valence) × 2 (arousal) × 2 (movement direction) repeated-measures ANOVA. There was a main effect for movement direction, $F(1, 14) = 324.69$, $p = .00$, such that movements were

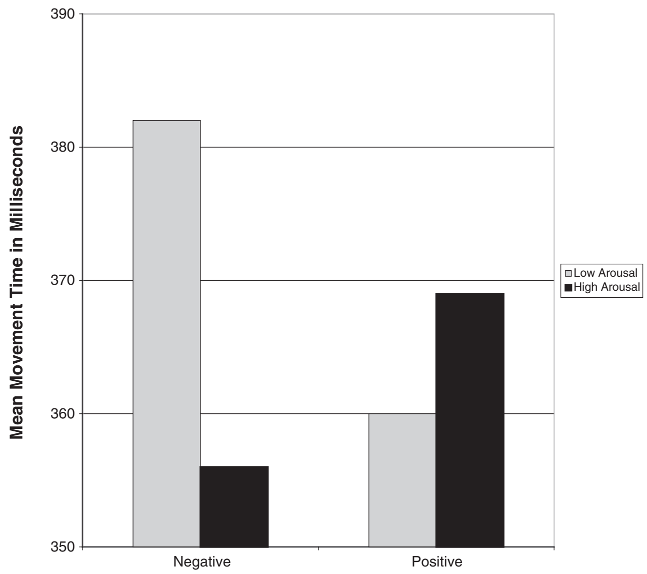

Figure 4 Motor latencies by valence and arousal, Study 5.

faster in the backward direction ($M = 155$ ms) than in the forward direction ($M = 578$ ms). In addition, there was a Valence × Arousal interaction, $F(1, 14) = 5.24$, $p = .04$. The relevant means are shown in Figure 4. None of the other effects were significant, all ps > .50.[5]

Discussion

The results of Studies 4 and 5, similar to the results of Studies 2 and 3, cannot be reconciled with the view that valence and arousal are completely independent in evaluative processing, and they cannot support the view that arousal merely reflects activation of approach or avoidance systems. Instead, our effects are compatible with proposals that intense stimuli, which elicit the orienting response (McCurdy, 1950), are categorized as aversive during early stages of encoding (Zajonc, 1998).

Before turning to the issue of whether our results are unique to pictorial stimuli, we sought to conduct a meta-analysis of the findings reported in Studies 1 through 5. The relevant analyses serve two purposes. One, with this new data set, we were able to control for identification latencies (collected in Study 1). And two, we could treat valence and arousal in a dimensional, rather than categorical, manner. For the sake of convenience, we refer to this meta-analysis as Study 6.

STUDY 6

Method

We created a new data set, with slide ($N = 56$) as the unit of analysis. In creating this data set, we first added z

scored norms related to valence and arousal and their interaction, based on the Lang et al. (1999) means. We then added log-transformed identification means from Study 1. Such identification means were computed separately for each slide, averaged across all of the participants in that study. Finally, we added log-transformed evaluation latencies for each slide, which were collected in Studies 2 and 3, as well as log-transformed incidental performance measures, which were collected in Studies 4 and 5.

Results

In an initial multiple regression, we entered *z* scores for valence, arousal, and their interaction in a regression predicting identification latencies. The regression indicated that the more arousing the slide, the faster its main theme was identified, $t = -3.20$, $p = .00$. There was also a marginal hint in this regression that slides higher in valence were identified more quickly than were slides lower in valence, $t = -1.94$, $p = .06$. However, the interaction between valence and arousal was not significant, $t < 1$. This regression confirms that the interactions reported in this article are not due to the visual complexity of the slides.

We next sought to examine the interactive effects of valence and arousal in predicting the dependent measures collected in Studies 2 through 5. In these regressions, we simultaneously entered the following terms: *z* scored identification, *z* scored valence, *z* scored arousal, and a term to represent the valence by arousal interaction. The results, in terms of Beta coefficients and significance, are reported in Table 1.

In the studies (2 and 3) involving explicit evaluations, identification latencies were a positive predictor of performance. In other words, knowing what something is (i.e., identification) is an important predictor of being able to determine whether it is good or bad (i.e., evaluation). Identification latencies also positively predicted incidental motor performance (Studies 4 and 5), but not significantly so. The Valence × Arousal interaction was significant in all five regressions. In other words, the more arousing the slide, the faster (implicit or explicit) evaluation latencies were for negative slides, but the slower they were for positive slides.

TABLE 1: Multiple Regression Predictors of Evaluation Latencies and Incidental Motor Performance, Study 6

	Predictor			
Dependent Measure	*Identification*	*Valence*	*Arousal*	*Interaction*
Evaluation time, Study 2	.44*	.09	.00	.45*
Evaluation time, Study 3	.55*	.21	.09	.25*
Feeling time, Study 3	.41*	–.02	.02	.31*
Dot discrimination, Study 4	.23	–.08	.17	.29*
Motor behavior, Study 5	.26	–.02	.03	.27*

NOTE: With slide ($N = 56$) as unit of analysis, we performed five multiple regressions, one for each of the dependent measures reported in this table. Predictors were simultaneously entered. Depicted in the table are standardized Betas resulting from these regressions.
*$p < .05$.

STUDY 7

Although the use of a constant set of stimuli has benefits, as the meta-analysis shows, this stimulus selection procedure also may have costs. Specifically, because we only used emotional slides as stimuli in the prior studies, it is unknown whether a similar Valence × Arousal interaction would generalize to the evaluation of emotional words. We sought to investigate this issue in Study 7.

Method

Participants. Participants were 28 undergraduates from North Dakota State University.

Stimuli. Word stimuli were chosen on the basis of norms compiled by Bradley and Lang (1999). The investigators asked raters to use pictorial scales to determine the valence (1 = unpleasant, 9 = pleasant) and arousal (1 = low, 9 = high) of each of the words. Bradley and Lang also obtained word frequency norms from Kucera and Francis (1967).

In selecting stimuli from the Bradley and Lang (1999) norms, we sought to satisfy multiple constraints. First, low and high arousal words should be equal in valence. Second, the extremity of negative and positive words should be equal. Third, negative and positive words should be equal in arousal. And fourth, all four categories of words should be equal in word frequency. A careful iterative process satisfied all of these constraints and produced 35 words per category.[6]

To examine the effectiveness of our selection procedures, we created dummy codes to represent valence (–1 = negative, +1 = positive) and arousal (–1 = low, +1 = high) selection criteria. We then used these dummy codes to examine the original rating norms provided by Bradley and Lang (1999). These analyses were conducted with word ($N = 140$) as the unit of analysis within repeated-measures ANOVAs. With valence ratings as the dependent measure, valence had a significant effect (*M*s = 3.27 and 6.73 for negative and positive words, respectively), $F(1, 138) = 3187.57$, $p = .00$, whereas arousal and the Valence × Arousal interaction did not, *F*s < 1. With extremity as the dependent measure, none of the factors were significant predictors, *F*s < 1. With arousal ratings as the dependent measure, arousal had a significant effect (*M*s = 4.23 and 5.81 for low and high arousal words, respectively), $F(1, 138) = 349.04$, $p = .00$, whereas valence and the Valence × Arousal interaction did not, *F*s < 1. Finally, with word frequency norms as the dependent measure, none of the factors were significant predictors, *F*s < 1. In sum, the word selection process was successful.

Procedures. The collection of the data was conducted in the context of small group sessions. Word stimuli were displayed on computer monitors. Participants were asked to both identify and evaluate the 140 stimulus words. We used two counterbalancing procedures. First, via random assignment procedures, 12 of the 28 participants were assigned to a condition in which they made identifications before making evaluations; the remaining participants completed the tasks in the opposite order. Second, in the evaluation task itself, we counterbalanced whether the 1 key at the top of the keyboard (n = 13) or the 9 key (n = 15) represented a positive evaluation.

In the identification task, participants were asked to press the spacebar as soon as they could identify the word in question. In the evaluation task, participants were asked to evaluate the word by pressing either the 1 or 9 key at the top of the keyboard. In neither of the tasks did we provide accuracy feedback. Words were randomly selected for each participant for each task. Trial procedures involved the presentation of a single word on the computer screen. The timing began with the appearance of the word and ended with a relevant response. After a response, there was a 500-ms delay until the next word was presented.

Results

Participant-level analyses. Prior to conducting participant-level analyses, we deleted the inaccurate evaluations. We then log-transformed latencies and replaced times that were 2.5 *SD*s below or above the grand latency mean, separately for each task. Log-latency means were then averaged within cells of a 2 (valence: negative vs. positive) × 2 (arousal: low vs. high) × 2 (task: identification vs. evaluation) within-subject design. We also retained the between-subjects factor of task order in the relevant ANOVA. Significant effects will be reported in terms of milliseconds.

There were no effects for task order, *p*s > .20, save an Arousal × Task × Task Order interaction, $F(1, 26) = 6.87$, $p = .01$, that was neither predicted nor informative. However, there were main effects for valence (*M*s = 904 and 861 ms for negative and positive words, respectively), $F(1, 26) = 8.99$, $p = .01$, arousal (*M*s = 866 and 900 ms for low and high arousal words, respectively), and task (*M*s = 789 and 977 ms for identification and evaluation tasks, respectively), $F(1, 26) = 10.35$, $p = .00$. Neither the Valence × Task nor the Arousal × Task interactions were significant, *p*s > .05.

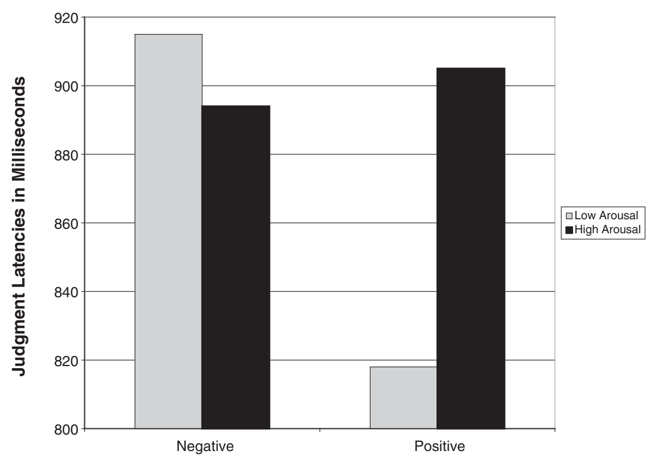

Figure 5 Judgment latencies by valence and arousal, Study 7.

Of most importance was the significant Valence × Arousal interaction, $F(1, 26) = 43.23$, $p = .00$. The interaction was cross-over in nature. As shown in Figure 5, participants were faster to process (i.e., identify or evaluate) negative words when they were high in arousal; by contrast, they were faster to process positive words when they were low in arousal. Finally, there was some indication that the Valence × Arousal interaction was more pronounced for the evaluation task than for the identification task, but the Valence × Arousal × Task interaction was not significant, $F(1, 26) = 2.83$, $p = .10$. We sought to supplement these results with additional results involving word as the unit of analysis.[7]

Word-level analyses. Given that task order did not affect the pattern of results in any substantial way, means were collapsed across this variable. We created a new data set with word (N = 140) as the unit of analysis. For each word separately, we entered independent variables related to z scored valence and arousal. Both were continuous measures and both were based on the Bradley and Lang (1999) norms. We also entered frequency norms from Kucera and Francis (1967). Finally, for each word separately, we obtained identification and evaluation latencies averaged across participants.

We initially performed a multiple regression designed to replicate the analyses reported above, here with word as the unit of analysis. In this regression, log-transformed evaluation latencies were predicted on the basis of z scores related to valence, arousal, and their interaction. The main effect for valence was not significant, $t = -1.11$, $p = .27$. However, we replicated a main effect for the arousal level of the word, $t = 2.60$, $p = .01$, as well as the Valence × Arousal interaction, $t = 3.76$, $p = .00$. Estimated means (+ or –1 *SD*), obtained from a regression equation, revealed that the interaction was quite parallel to that reported above.

In a second multiple regression, we sought to test the robustness of the interaction with other factors controlled. In this equation, the dependent measure consisted of log-transformed evaluation latencies. Predictor variables consisted of identification latencies and word frequency values in addition to z scores related to valence, arousal, and their interaction. As in Study 6, identification latencies were a significant predictor of evaluation latencies, $t = 3.72$, $p = .00$. However, frequency and valence main effects were not significant, $ts < 1$. Replicating the analyses reported above, there was a main effect for arousal, $t = 2.59$, $p = .01$, as well as the hypothesized Valence × Arousal interaction, $t = 3.05$, $p = .00$.

Discussion

Pictorial and word stimuli differ in a number of ways, such as imageability and capacity to induce strong physiological activity (Lang et al., 1997). In addition, access to word meaning obviously relies to a greater degree on symbolic linguistic activity. One might therefore expect some differences in the processing of pictures and words. Indeed, whereas high arousal pictures were identified more quickly (Study 1), high arousal words were identified more slowly (Study 7). A possible reason for the discrepancy is that high arousal stimuli both (a) activate the right hemisphere (Robinson & Compton, 2004) and (b) the right hemisphere is better at picture processing, whereas the left hemisphere is better at word processing (Hellige, 1990). However, a systematic comparison of word and picture processing was clearly not the focus of the present studies and therefore this interpretation should be viewed with caution.

More important than the identification-related differences were the results that replicated across both picture and word stimulus sets. Specifically, there was a Valence × Arousal interaction such that high arousal facilitated evaluations of negative stimuli and interfered with evaluations of positive stimuli. Given the parallel interactions involving the evaluation of pictures and words, the current findings cannot be due to the nature of the particular stimuli involved. Rather, a broader principle appears to be operative.

GENERAL DISCUSSION

Major Findings

In seven studies, we found consistent support for the idea that stimulus valence and arousal interactively influence evaluative processing. Study 1 first established that there was no Valence × Arousal interaction involving the visual complexity of slides. This was an important null result because it paved the way for subsequent studies examining evaluation latencies. As expected, we observed a significant Valence × Arousal interaction in Studies 2 and 3, such that negative/high arousal and positive/low arousal slides were evaluated more quickly than their valence-matched counterparts. Study 7 showed that a parallel pattern is apparent when people evaluate word stimuli.

Although the possibility seems somewhat unlikely to us, particularly as latencies were involved and responses were made in the dark, it could be the case that participants felt somewhat hesitant in reporting positive evaluations of slides within the positive/high arousal category. Similar concerns, however, cannot be offered concerning the covert evaluation findings reported in Studies 4 and 5. In these studies, participants made no public evaluations of the slides. Rather, slide evaluation difficulties were inferred from performance on a neutral secondary task. Because we observed the same Valence × Arousal interactions in these studies, we conclude that evaluative processing was genuinely delayed in the case of negative/low arousal and positive/high arousal slides.

It is important to note that effects pertaining to the Valence × Arousal interaction were apparent both with participant as the unit of analysis (Studies 2-5 and 7) and with stimulus as the unit of analysis (Studies 6 and 7). The latter findings add to the strengths of the article in that cognitive psychologists are often more impressed by findings that replicate across both participant-level and item-level analyses. More important, however, the relevant analyses were able to confirm that the Valence × Arousal interaction was replicated within the context of continuous variations in valence and arousal, even with stimulus identification processes controlled.

Stimulus Arousal and Negative Connotation

The present results, although novel, dovetail to some extent with prior results. First, Lang et al. (1997) report that it is extremely difficult to find strongly negative slides that are low in emotional arousal. This is also true of emotional words and sounds (Lang et al., 1997). One inference from these prior norming data is that valence and arousal covary in the real world such that negative stimuli tend to be arousing. If this is true, it is not completely erroneous to infer that, pending further analysis, an arousing stimulus is likely to be a negative one. Two, Lang (1995) has reported some preliminary data indicating that not all negative slides elicit the same level of affect-modulated startle responses. Specifically, stimuli that are negative and low in arousal, such as those related to pity, tend to elicit smaller amplitude startle responses than could be expected on the basis of their valence. By contrast, stimuli that are negative and high in arousal, such as those related to fear, tend to elicit larger amplitude startle responses than could be expected on the basis of their valence. The latter findings fit with data linking the startle response specifically to negative/high arousal states and amygdala functioning (Lang, Davis, & Öhman, 2000).

In a related vein, there is extensive evidence suggesting that the orienting response, triggered by arousing stimuli, is anything but valence-neutral at the preattentive level (Öhman, Esteves, Flykt, & Soares, 1993). Rather, arousing stimuli that are negative in general and fearful in particular seem to have a special ability to capture preattentive orienting based on arousal (Öhman, 1997; Robinson, 1998). To the extent that people link such a preattentive "alarm system" to negative valence, they appear to do so on solid empirical grounds. That is, preattentive triggers of the orienting response may indeed be negative more often than positive. In addition, from a decision-making perspective, people are generally better off assuming that arousing stimuli are negative until they can determine otherwise. This is specifically because the costs of not acting quickly enough when a danger is present considerably outweigh the costs of reacting relatively slowly when a potential reward is involved (Kahneman & Tversky, 1984; Robinson, 1998).

It is probably no coincidence that another major line of research concerning subliminal affect also concludes that orienting is negatively biased when subliminal stimuli are involved. Specifically, there is plenty of evidence, from the mere exposure literature, that people regard novel stimuli, which induce uncertainty and orienting, as negative in connotation (e.g., Bornstein, 1989). A stimulus that is entirely novel, relative to a stimulus that has been subliminally repeated, elicits larger skin conductance responses and more negative judgments. The covariation of these effects suggests that stimulus novelty, which is highly correlated with stimulus arousal (McCurdy, 1950), might be a cue to negative valence (also see Bronson, 1968). Relatedly, Robinson and Clore (2001) found that judgments of stimulus novelty covaried with perceptions of danger and negative emotions, whereas judgments of stimulus familiarity covaried with perceptions of safety and positive emotions.

As a final consideration, we note that certain populations, especially those less capable of instrumental coping, provide support for the link between stimulus arousal and negative connotation. First, there is the data of Schneirla (1959), who showed that multiple lower organisms (e.g., the ant) routinely avoid stimuli of high intensity. Second, there is the data collected in studies of early emotional development showing that infants react with distress to high arousal stimuli (Harman & Fox, 1997; Rothbart et al., 1990). Third, there is data showing that people with anxiety disorders in general and phobic disorders in particular react disproportionately to high arousal stimuli (Barlow, 2002). Such results suggest that the Valence × Arousal interaction observed in our studies may be parallel to the manifest distress exhibited by vulnerable individuals when an arousing stimulus is present.

In sum, our ability to engage in further analysis and determine that a positive/high arousal stimulus is in fact benign may not be present from birth and may be a relatively late development within the evaluative architecture of human adults. The present results, however, suggest that the association between arousing events and negative connotation is not limited to vulnerable individuals (e.g., infants); rather, this association influences early stages of stimulus encoding, albeit covertly, among human adults as well.

Conclusions

Although stimulus valence and arousal may be independent with reference to some dependent measures (e.g., self-report), this need not be the case for all dependent measures (e.g., evaluation latencies). We suggest, as we have suggested elsewhere (e.g., Robinson, 2004), that there is no necessary reason to assume that latency-based measures of affective processing will necessarily converge with self-report measures. Other authors too have made distinctions between the real-time processing of affective stimuli and the evaluative outputs that might arise from such processing (e.g., Cacioppo, Gardner, & Berntson, 1999). Because affective processes and self-reports concern distinct levels of analysis, there may be no reason to assume that inferences based on one level of analysis necessarily generalize to the other. And yet, affective outputs (e.g., self-reports of emotional states) must ultimately be explained in terms of the cognitive processes that intervene between emotional stimulus and emotional response. Thus, although difficulties in mapping the cognitive level of analysis to the structural level of analysis are apparent at the present time, a continued focus on affective processing, in addition to the more traditional measures examined within this area (e.g., self-report), will likely bring about such a rapprochement.

NOTES

1. In terms of Lang, Bradley, and Cuthbert's (1999) slide numbers, negative/high arousal slides consisted of Slide Numbers 1050, 1120, 1300, 1301, 1930, 3130, 3250, 6260, 6300, 6510, 6570, 7380, 9300, and 9570; negative/low arousal slides consisted of Slide Numbers 1111, 1220, 2053, 2520, 2800, 3230, 3350, 7361, 9008, 9290, 9320, 9415, 9421, and 9561; positive/high arousal slides consisted of Slide Numbers 4599, 4607, 4608, 4641, 4651, 4652, 4660, 5621, 8180, 8200, 8370, 8380, 8470, and 8490; and positive/low arousal slides consisted of Slide Numbers 1440, 1460, 1750, 1810, 2040, 2050, 2057, 2070, 2165, 2352, 2550, 2660, 4606, and 8350.

2. Study 2 also included the presentation of short-duration (150 SOA) prime picture slides displayed from a second projector. This priming manipulation was irrelevant to purposes at hand.

3. There was also a Valence × Arousal interaction pertaining to accuracy rates, $F(1, 20) = 29.89$, $p = .00$. Evaluations of negative slides were more accurate if the slide was also high ($M = 95.6\%$) versus low ($M = 86.2\%$) in arousal; evaluations of positive slides were more accurate if the slide was also low ($M = 92.2\%$) versus high ($M = 86.2\%$) in arousal.

4. There was also a significant Valence × Arousal interaction affecting accuracy rates, both with the evaluation task, $F(1, 19) = 22.75$, $p = .00$ (Ms = 86.4%, 96.8%, 95.0%, and 93.2% for negative/low arousal, negative/high arousal, positive/low arousal, and positive/high arousal slides, respectively) and within the feeling judgment task, $F(1, 19) = 12.69$, $p = .00$ (Ms = 90.4%, 99.3%, 95.7%, and 94.3%).

5. It is worth noting that a forward motion can either be viewed as an approach-related behavior (e.g., grasping the stimulus) or as an avoidance-related behavior (e.g., pushing the stimulus away). Given that motions are flexible in their potential interpretation, one would not necessarily expect direction-specific affect/motor priming effects in the current context.

6. Contact the first author for a list of word stimuli.

7. An analysis of accuracy rates revealed a main effect for arousal, $F(1, 26) = 59.44$, $p = .00$ (Ms = 93.3% and 87.1% for low and high arousal words, respectively), and a Valence × Arousal interaction, $F(1, 26) = 20.65$, $p = .00$ (Ms = 89.9%, 88.6%, 96.6%, and 85.7% for negative/low arousal, negative/high arousal, positive/low arousal, and positive/high arousal words, respectively).

REFERENCES

Bargh, J. A., Chaiken, S., Govender, R., & Pratto, F. (1992). The generality of the automatic attitude activation effect. *Journal of Personality and Social Psychology, 62*, 893-912.

Barlow, D. H. (2002). *Anxiety and its disorders: The nature and treatment of anxiety and panic* (2nd ed.). New York: Guilford.

Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968-1987. *Psychological Bulletin, 106*, 265-289.

Bradley, M. M., & Lang, P. J. (1999). *Affective norms for English words (ANEW)*. Gainesville, FL: The National Institute of Mental Health Center for the Study of Emotion and Attention, University of Florida.

Bronson, G. W. (1968). The fear of novelty. *Psychological Bulletin, 69*, 350-358.

Cacioppo, J. T., Gardner, W. L., & Berntson, G. G. (1999). The affect system has parallel and integrative processing components: Form follows function. *Journal of Personality and Social Psychology, 76*, 839-855.

De Houwer, J., & Eelen, P. (1998). An affective variant of the Simon paradigm. *Cognition and Emotion, 12*, 45-61.

Dijksterhuis, A., & Aarts, H. (2003). On wildebeests and humans: The preferential detection of negative stimuli. *Psychological Science, 14*, 14-18.

Erber, R., & Erber, M. W. (2000). The self-regulation of moods: Second thoughts on the importance of happiness in everyday life. *Psychological Inquiry, 11*, 142-148.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology, 74*, 1464-1480.

Harman, C., & Fox, N. A. (1997). Frontal and attentional mechanisms regulating distress experience and expression during infancy. In N. A. Krasnegor, G. R. Lyon, & P. S. Goldman-Rakic (Eds.), *Development of the prefrontal cortex: Evolution, neurobiology, and behavior* (pp. 191-208). Baltimore: Paul H. Brookes.

Heller, W., & Nitschke, J. B. (1998). The puzzle of regional brain activity in depression and anxiety: The importance of subtypes and comorbidity. *Cognition and Emotion, 12*, 421-447.

Hellige, J. B. (1990). Hemispheric asymmetry. *Annual Review of Psychology, 41*, 55-80.

Izard, C. E. (1993). Organizational and motivational functions of discrete emotions. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 631-641). New York: Guilford.

Kahneman, D., & Tversky, A. (1984). Choices, values, and frames. *American Psychologist, 39*, 341-350.

Klauer, K. C., & Musch, J. (2003). Affective priming: Findings and theories. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 7-49). Mahwah, NJ: Lawrence Erlbaum.

Kucera, H., & Francis, W. N. (1967). *Computational analysis of present-day American English*. Providence, RI: Brown University Press.

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist, 50*, 372-385.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simons, & M. Balaban (Eds.), *Attention and emotion: Sensory and motivational processes* (pp. 97-135). Mahwah, NJ: Lawrence Erlbaum.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International affective picture system (IAPS): Technical manual and affective ratings*. Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Lang, P. J., Bradley, M. M., Fitzsimmons, J. R., Cuthbert, B. N., Scott, J. D., Moulder, B., et al. (1998). Emotional arousal and activation of the visual cortex: An fMRI analysis. *Psychophysiology, 35*, 199-210.

Lang, P. J., Davis, M., & Öhman, A. (2000). Fear and anxiety: Animal models and human cognitive psychophysiology. *Journal of Affective Disorders, 61*, 137-159.

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30*, 261-273.

McCurdy, H. G. (1950). Consciousness and the galvanometer. *Psychological Review, 57*, 322-327.

Murphy, S. T., & Zajonc, R. B. (1993). Affect, cognition, and awareness: Affective priming with optimal and suboptimal stimulus exposures. *Journal of Personality and Social Psychology, 64*, 723-739.

Neumann, R., Förster, J., & Strack, F. (2003). Motor compatibility: The bidirectional link between behavior and evaluation. In J. Musch & K. C. Klauer (Eds.), *The psychology of evaluation: Affective processes in cognition and emotion* (pp. 371-391). Mahwah, NJ: Lawrence Erlbaum.

Öhman, A. (1997). As fast as the blink of an eye: Evolutionary preparedness for preattentive processing of threat. In P. J. Lang, R. F. Simons, & M. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes* (pp. 165-184). Mahwah, NJ: Lawrence Erlbaum.

Öhman, A., Esteves, F., Flykt, A., & Soares, J. J. F. (1993). Gateways to consciousness: Emotion, attention, and electrodermal activity. In J. C. Roy, W. Boucsein, D. C. Fowles, & J. H. Gruzelier (Eds.), *Progress in electrodermal research* (pp. 137-157). New York: Plenum.

Osgood, C. E. (1969). On the whys and wherefores of E, P, and A. *Journal of Personality and Social Psychology, 12*, 194-199.

Pashler, H., Johnston, J. C., & Ruthruff, E. (2000). Attention and performance. *Annual Review of Psychology, 52*, 629-651.

Pratto, F. (1994). Consciousness and automatic evaluation. In P. M. Niedenthal & S. Kitayama (Eds.), *The heart's eye: Emotional influences in perception and attention* (pp. 115-143). San Diego, CA: Academic Press.

Robinson, M. D. (1998). Running from William James' bear: A review of preattentive mechanisms and their contributions to emotional experience. *Cognition and Emotion, 12*, 667-696.

Robinson, M. D. (2004). Personality as performance: Categorization tendencies and their correlates. *Current Directions in Psychological Science, 13*, 127-129.

Robinson, M. D., & Clore, G. L. (2001). Simulation, scenarios, and emotional appraisal: Testing the convergence of real and imagined reactions to emotional stimuli. *Personality and Social Psychology Bulletin, 27*, 1520-1532.

Robinson, M. D., & Clore, G. L. (2002). Episodic and semantic knowledge in emotional self-report: Evidence for two judgment processes. *Journal of Personality and Social Psychology, 83*, 198-215.

Robinson, M. D., & Compton, R. J. (2004). *Motivating the spotlight: The lateralizing effects of emotional arousal*. Manuscript submitted for publication.

Rothbart, M. K., Posner, M. I., & Boylan, A. (1990). Regulatory mechanisms in infant development. In J. T. Enns (Ed.), *The development* *of attention: Research and theory* (pp. 47-66). Oxford, UK: North-Holland.

Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*, 805-819.

Schneirla, T. (1959). An evolutionary and developmental theory of biphasic processes underlying approach and withdrawal. In M. Jones (Ed.), *Nebraska symposium on motivation* (Vol. 7, pp. 1-42). Lincoln: University of Nebraska Press.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*, 820-838.

Zajonc, R. B. (1998). Emotions. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (pp. 591-632). Boston: McGraw-Hill.

Zajonc, R. B. (2001). Mere exposure: A gateway to the subliminal. *Current Directions in Psychological Science, 10*, 224-228.

Received December 6, 2003
Revision accepted April 23, 2004