Common and Distinct Patterns of Affective Response in Dimensions of Anxiety and Depression

Christine L. Larson
Michigan State University

Jack B. Nitschke and Richard J. Davidson
University of Wisconsin—Madison

The authors examined the time course of affective responding associated with different affective dimensions—anxious apprehension, anxious arousal, and anhedonic depression—using an emotion-modulated startle paradigm. Participants high on 1 of these 3 dimensions and nonsymptomatic control participants viewed a series of affective pictures with acoustic startle probes presented before, during, and after the stimuli. All groups exhibited startle potentiation during unpleasant pictures and in anticipation of both pleasant and unpleasant pictures. Compared with control participants, symptomatic participants exhibited sustained potentiation following the offset of unpleasant stimuli and a lack of blink attenuation during and following pleasant stimuli. Common and unique patterns of affective responses in the 3 types of mood symptoms are discussed.

Keywords: startle reflex, emotion, anxiety, depression, positive affect, negative affect

It has long been established that anxiety and depression often co-occur (see Clark & Watson, 1991, for a review; Kessler et al., 1994; Zimmerman, McDermut, & Mattia, 2000). This substantial comorbidity has led to research examining whether anxiety and depression represent different manifestations of the same underlying pathogenesis and to what extent they can be considered distinct disorders. Much of this work has focused on the extent to which these disorders share common or unique affective properties, particularly the magnitude of positive affect (PA) and negative affect (NA; see Watson, 2000, for a review). In addition, anxiety researchers have identified fundamental characteristics that differentiate different classes of anxiety, with the constructs of anxious arousal and anxious apprehension, or worry, emerging as distinct subtypes (Andrews & Borkovec, 1988; Nitschke, Heller, Imig, McDonald, & Miller, 2001). More recently, in a separate line of research, emotion researchers have begun to highlight the need to consider individual differences in not just the magnitude but also the temporal dynamics of affective responses in understanding psychopathology (Davidson, 1998; Watson, 2000). A primary aim of the present study was to merge these two parallel examinations

of the affective characteristics of anxiety and depression to identify aspects of magnitude and time course of responses to pleasant and aversive affective stimuli that are similar or distinct for depressive symptoms and different forms of anxiety. We used a psychophysiological measure, the emotion-modulated startle paradigm, to assess these patterns of affective response.

Affect and the Structure of Depression and Anxiety

One influential line of research on depression and anxiety has focused on the extent to which they differ in their affective structure. At the forefront of this endeavor was work by Clark and Watson and colleagues examining the relationship between depression and anxiety to PA and NA (Clark & Watson, 1991; Watson, Clark, et al., 1995; Watson, Weber, et al., 1995). Through systematic examinations of these relationships in both patient and nonpatient populations, they identified NA as a common distress factor evident in both depression and anxiety. In contrast, deficits in PA were found to be specific to depression, and the dimension of anxious arousal, reflecting somatic and autonomic symptoms, was unique to anxiety. These common and specific features of depression and anxiety served as the basis of their tripartite model (Clark & Watson, 1991). Other work examining the structure of mood and anxiety disorders has been broadly consistent with this model (Brown, Chorpita, & Barlow, 1998; Nitschke et al., 2001; Zinbarg & Barlow, 1996).

Attempts at further refining models of the hierarchical structure of depression and anxiety have considered subtypes or dimensions (Brown et al., 1998; Cuthbert et al., 2003; Heller & Nitschke, 1998; Zinbarg & Barlow, 1996). Indeed, the tripartite model has been reformulated to incorporate additional anxiety disorder–specific dimensions and emphasize the importance of anxious arousal for panic-related symptoms, rather than as a universal characteristic of all anxiety disorders (Mineka, Watson, & Clark, 1998). From this growing literature on subtypes of anxiety, one primary distinction differentiates anxious apprehension and anxious arousal (Andrews & Borkovec, 1988; Barlow, 1991; Nitschke

et al., 2001). Anxious apprehension is characterized by worry over future events in the immediate or even the distant future. It is often called worry or cognitive anxiety. In contrast, anxious arousal is characterized by intense, immediate fear and is associated with a host of physiological symptoms, including racing or pounding heart, sweating, trembling, shortness of breath, and other symptoms related to panic and acute fear. These two forms of anxiety often co-occur and can be present in all anxiety disorders. Furthermore, they are often reported by individuals diagnosed with depressive disorders. Different patterns of regional brain activity have been implicated in anxious arousal and anxious apprehension (Heller & Nitschke, 1998; Heller, Nitschke, Etienne, & Miller, 1997; Nitschke, Heller, & Miller, 2000; Nitschke, Heller, Palmieri, & Miller, 1999). Thus, mounting evidence has highlighted the utility of considering the structure of PA and NA along with different forms of anxiety in understanding common and unique characteristics of anxiety and depression.

Affective Chronometry

Although there is now a growing body of research supporting the important role of magnitude of PA and NA in depression and anxiety, relatively little work has examined how other facets of the dynamics of affective responding may be linked with these symptoms. Davidson (1998; Davidson, Jackson, & Kalin, 2000) has emphasized that individual differences in the time course of emotion, or affective chronometry, may be importantly linked with trait affective style and vulnerability to affective disorders. The major facets of affective chronometry include the threshold determining a response, the magnitude of the response, the rise time to peak response, and the recovery function and duration of response. As Schimmack, Oishi, Diener, and Suh (2000) pointed out, these chronometric properties have received less attention than intensity and frequency of affective experience. However, recent empirical work has begun to demonstrate the importance of individual differences in the temporal properties of affect. Rate of affect change has been found to be strongly linked to individual differences in neuroticism (Shuls, Green, & Hillis, 1998) and extraversion (Hemenover, 2003), such that neuroticism was associated with rapid enhancement and slow decay of NA and rapid decay of PA, whereas extraversion was linked with rapid onset and slow decay of PA and rapid decay of NA.

Slower decay of NA has also been linked with symptoms of depression and patterns of resting brain activation that have been associated with depressive features and NA (Jackson et al., 2003; Larson & Davidson, 2001). Moreover, a growing number of studies are reporting sustained processing of negative information in depression, even in very brief affective contexts, providing a window on how this dysregulation of emotion may lead to increased vulnerability to depression in the face of more substantial negative life stressors. Recent work using a variety of techniques, including event-related potentials (ERPs), pupillary dilation, and respiratory sinus arrhythmia, has indicated that sustained affective responding in the seconds just following the offset of an unpleasant stimulus is associated with depression (Deldin, Deveney, Kim, Casas, & Best, 2001; Deveney & Deldin, 2004; Rottenberg, Kasch, Gross, & Gotlib, 2002; Siegle, Granholm, Ingram, & Matt, 2001; Siegle, Steinhauer, Carter, Ramel, & Thase, 2003). Induced dysphoric states have also been associated with prolonged facial electromyographic responses (Sirota, Schwartz, & Kristeller, 1987). Siegle, Steinhauer, Thase, Stenger, and Carter (2002) further identified that this sustained processing in depression was linked with prolonged activation of the amygdala. More important, this sustained amygdala activation and pupillary dilation to unpleasant words was correlated with self-reported rumination, a hallmark feature of depression that may be closely linked to sustained processing of negative information. Nolen-Hoeksema and others have repeatedly found that rumination, defined as perseverative focus on one's depressed mood and symptoms, prolongs and intensifies episodes of depression (Nolen-Hoeksema, 1991; Nolen-Hoeksema, Morrow, & Fredrickson, 1993) and predicts vulnerability to future episodes (Spasojevic & Alloy, 2001). In light of the links between sustained responses to negative information, rumination, and symptoms of depression, we set out to replicate this finding in the present study and test the specificity of these effects to depressive symptoms. Sustained processing of negative information and other facets of affective chronometry have not been documented or rigorously examined in anxiety or its subtypes.

Emotion Modulation of Startle Blink in Depression and Anxiety

The heightened negative affect common to both depression and anxiety (Clark & Watson, 1991; Nitschke et al., 2001) leads to the prediction of exaggerated responses to unpleasant stimuli. Although some studies have found that depressed people have greater responses to unpleasant stimuli (Cook, Davis, Hawk, & Spence, 1992; Cook, Hawk, Davis, & Stevenson, 1991), a number of other studies have found no abnormalities in depression or even a failure to show the normal potentiation of startle in response to unpleasant stimuli in depression (Dichter, Tomarken, Shelton, & Sutton, 2004; Kaviani et al., 2004), particularly in severely or recurrently depressed individuals (Allen, Trinder, & Brennan, 1999; Forbes, Miller, Cohn, Fox, & Kovacs, 2005). With respect to anxiety, increased potentiation of startle to unpleasant stimuli has been observed among people high on characteristics such as trait neuroticism, anxiety, harm avoidance, and fearfulness (Cook et al., 1992, 1991; Corr, 2002; Corr, Kumari, Wilson, Checkley, & Gray, 1997; Wilson, Kumari, Gray, & Corr, 2000). Enhanced blink potentiation to threat-related words has also been observed in patients with panic disorder and social phobia (Larsen, Norton, Walker, & Stein, 2002). Cuthbert and colleagues (2003) found that patients with social and specific phobia exhibited consistent fear potentiation of startle; however, panic and posttraumatic stress disorder patients tended not to show reliable startle potentiation, suggesting that fear potentiation of startle is more reliable in individuals with phobic disorders.

Previous work examining emotion modulation of startle blink in affective disorders has repeatedly found deficits in response to pleasant stimuli, as would be predicted by the tripartite model discussed above (Clark & Watson, 1991), with depressed individuals failing to show the typically observed attenuation of blink magnitude in response to pleasant pictures (Allen et al., 1999; Dichter et al., 2004) and film clips (Kaviani et al., 2004). Consistent findings have been reported for ERPs and electromyography (EMG; Shestyuk, Deldin, Brand, & Deveney, 2005; Sloan, Bradley, Dimoulas, & Lang, 2002; Sloan, Strauss, Quirk, & Stajatovic, 1997; Sloan, Strauss, & Wisner, 2001).

Current Study

We aimed to further clarify individual differences in affective response styles, paying particular attention to the time course of affect, in several dimensions of mood disturbance, including anhedonic depression, anxious apprehension, and anxious arousal. Three groups were selected, each containing individuals high on one of the three target dimensions and low on the other two. These three groups were also compared with a control group (low on all three dimensions). To assess affective chronometry, emotion modulation of blink responses to an acoustic startle probe was measured for all four groups at different points during affective picture viewing: during a cue predicting the affective tone of the subsequent picture, during the picture itself, and at several points in time following picture offset.

We hypothesized that emotion modulation of startle blink would vary over time as a function of group. Given the future-oriented aspect of worry in anxious apprehension, we initially predicted enhanced potentiation of startle in anticipation of unpleasant stimuli among participants reporting high levels of anxious apprehension. However, as previously reported elsewhere we found no differences between symptom groups in the anticipation of pleasant or unpleasant stimuli (Nitschke et al., 2002), a finding replicated by Dichter, Tomarken, and Baucom (2002). Thus, although this probe time was included in the omnibus analysis, the present report is focused primarily on responses during and following picture presentation. On the basis of the hyperresponsivity aspect of anxious arousal (Clark & Watson, 1991; Watson, Weber, et al., 1995; Larsen et al., 2002), the normal potentiation of blink responses during aversive pictures was predicted to be augmented among participants with symptoms of anxious arousal. Also on the basis of previous work, responses to negative pictures were expected to be sustained following stimulus offset among the participants with symptoms of depression (Rottenberg et al., 2002; Siegle et al., 2001, 2003; Sirota et al., 1987). Participants high on anhedonic depression were also expected to fail to exhibit the normal attenuation of blink reflex magnitude during and following pleasant pictures (Allen et al., 1999; Dichter et al., 2004).

Method

Participants

Participants were 201 male and female undergraduates between the ages of 18 and 25 selected from more than 2,000 University of Wisconsin—Madison introductory psychology students based on their responses to the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990) and the Mood and Anxiety Symptom Questionnaire (MASQ; Watson, Clark, et al., 1995). Participants were not screened for psychiatric diagnoses or psychoactive medication. Forty-three were dropped due to lack of blink responses to the startle probe or to excessive noise in the recording. An additional 6 were dropped due to an insufficient number of good responses per condition (see below), yielding a total of 152 participants. Those scoring above the 80th percentile on a target scale (PSWQ, MASQ Anxious Arousal [MASQ-AA], MASQ Anhedonic Depression [MASQ-AD]) and below the 50th percentile on the other two scales were assigned to the anxious apprehension ($n = 36$), anxious arousal ($n = 33$), and anhedonic depression ($n = 30$) groups. Those scoring below the 50th percentile on all three scales were classified as controls ($n = 53$).

The three scales (MASQ-AD, MASQ-AA, PSWQ) were administered again at the startle session (number of days between initial questionnaire administration and psychophysiology assessment: $M = 75.08$, $SD = 23.52$, range $= 24–119$) to select final groups with stable questionnaire scores ($n = 82$; 45 women, 87% Caucasian). Owing to regression to the mean on the self-report measures, the criteria for group inclusion were relaxed for the second assessment such that, with the exception of the anxious arousal group, the symptomatic groups were expected to exceed the 70th percentile on the target index and were below the 60th percentile on the other measures (anxious apprehension $n = 14$ [9 women]; anhedonic depression $n = 19$ [9 women]). Participants initially high on anxious arousal showed greater reductions on this measure from first to second assessment than did other groups. Thus, the threshold for inclusion in the anxious arousal group was exceeding the 60th percentile on MASQ-AA ($n = 10$; 7 women). Control participants were below the 60th percentile for all three measures ($n = 39$ [20 women]). Despite this relaxation of the criteria for group membership, all groups were still clearly significantly different from one another on the target dimensions, as well as the relevant MASQ general distress scales (General Distress: Depression and General Distress: Anxiety), which represent increased general NA (see Table 1 for the mean MASQ and PSWQ scores at the time of the startle session for each group).

Materials

Three categories of picture stimuli designed to elicit positive, negative, or neutral emotions were chosen from Shows 1 through 12 of the International Affective Picture System (Center for the Study of Emotion & Attention, 1999).[1] On the basis of published normative ratings (Lang, Bradley, & Cuthbert, 1999), pictures were selected such that aversive and pleasant pictures were of opposite valence, $t(82) = -68.24$, $p < .001$, but both highly arousing, $t(82) = .91$, $p > .36$ (see Table 2). Neutral pictures had arousal ratings that were much lower than either aversive or pleasant pictures and valence ratings that were average. Of the 126 pictures used, there were 42 of each picture category.

Procedure

After obtaining informed consent, participants were seated in a comfortable chair positioned approximately 0.5 m from a 17-in. (43.18-cm) NEC-6FG multisync monitor used for presenting the images. Before the picture presentation, electrodes for recording startle responses were placed and impedances checked. To famil-

---

[1] IAPS numbers used in this study were as follows: Unpleasant: 3000, 3010, 3015, 3030, 3051, 3053, 3060, 3071, 3080, 3100, 3102, 3120, 3130, 3140, 3150, 3168, 3170, 3266, 3350, 3400, 3500, 3530, 6212, 6230, 6260, 3212, 6313, 6350, 6360, 6510, 6560, 6570, 9040, 9252, 9410, 9500, 9560, 9570, 9800, 9810, 9910, 9921; Neutral: 1670, 2620, 5510, 5520, 5531, 5532, 5533, 5534, 5731, 6150, 7000, 7002, 7006, 7009, 7010, 7025, 7030, 7034, 7035, 7040, 7050, 7060, 7080, 7090, 7100, 7130, 7140, 7150, 7170, 7190, 7207, 7217, 7224, 7233, 7234, 7235, 7490, 7500, 7700, 7710, 7920, 9210; and Pleasant: 1710, 2216, 2391, 4599, 4660, 4670, 4680, 5260, 5270, 5450, 5460, 5470, 5480, 5621, 5623, 5629, 5700, 5910, 7230, 7270, 7502, 8030, 8034, 8080, 8170, 8180, 8185, 8190, 8200, 8210, 8300, 8340, 8370, 8380, 8400, 8420, 8470, 8500, 8501, 8502, 8510, 8531.

Table 1
Mean Anxiety and Depression Scale Scores for Each Group

| | Group | | | | | | | |
| | Anxious apprehension | | Anxious arousal | | Anhedonic depression | | Control | |
Scale	M	SD	M	SD	M	SD	M	SD
PSWQ	66.14_a	7.94	39.50_b	11.12	37.79_b	9.33	32.62_b	9.88
MASQ-AA	22.21_b	3.36	34.50_a	4.22	22.79_b	4.64	21.31_b	3.96
MASQ-AD	45.64_b	6.34	44.40_b	5.46	69.63_a	6.03	43.46_b	6.39
MASQ-GDA	19.86_b	3.51	25.20_a	3.58	19.89_b	4.54	18.31_b	4.12
MASQ-GDD	22.43_a	4.52	22.10_a	3.92	26.37_a	5.65	18.28_b	4.22

Note. Within a row, means with different subscripts are significantly different from one another (all $ps < .04$, Bonferroni-corrected for each scale). PSWQ = Penn State Worry Questionnaire; MASQ = Mood and Anxiety Symptom Questionnaire; AA = Anxious Arousal; AD = Anhedonic Depression; GDD = General Distress-Depression; GDA = General Distress-Anxiety.

iarize the participants with the procedure and habituate them to the acoustic startle probe, participants then viewed an introductory set of nine pictures, during eight of which startle probes were presented.

Pictures were presented in six blocks of 21 pictures, with 7 pictures of each valence included in each block. The presentation of the pictures and acoustic startle probes were controlled by in-house software. Pictures were presented for 6 s each in a quasi-random order, with the constraint that not more than two stimuli of a given valence were presented consecutively. Immediately before each picture, a large warning stimulus that indicated the valence of the coming picture was presented for 4 s. The positive pictures were preceded by a plus sign, negative pictures by a minus sign, and neutral pictures by a circle. Each picture was followed by a blank screen for 7–13 s (mean interstimulus interval was 10 s).

Acoustic startle probes were generated with a Coulbourn S81-02 noise generator and a Coulbourn S82-24 audio-mixer power amplifier and were delivered binaurally through Audio-Technica ATH-M3X headphones. The probe was a 40-ms burst of white noise at 95 dB with a nearly instantaneous rise time. Probes were presented during 9 trials of each valence at one of the following probe times: during the warning stimulus (1 s before the picture onset), during the picture (2 s post–picture onset) and during the intertrial interval (1.5, 3, and 6 s after picture offset). Thirteen trials did not contain any startle probes, and 22 trials contained two probes, one early and one late. Probe times were quasi-randomly assigned for each trial with the constraint that no more than two of each probe time occurred consecutively. Following the startle paradigm, participants completed the PSWQ and MASQ again.

Startle Recording and Quantification

Raw and integrated EMG were collected using two Sensormedics minielectrodes placed approximately 36 mm apart on the inferior left orbicularis muscle(van Boxtel, Boelhouwer, & Bos, 1998). The impedance for the electrode pair was less than 20 Kohms. EMG signals were amplified 10,000 times and filtered with a bandpass of 1–800 Hz using SAI Bioelectric amplifiers (SA Instrumentation Co., Caroga Lake, NY). A high-pass filter set at 30

Table 2
Valence and Arousal Ratings for Affective Pictures

| | Picture category | | | | | |
| | Aversive/unpleasant | | Neutral | | Pleasant | |
	M	SD	M	SD	M	SD
			Valence			
Men	2.22_a	0.38	4.98_b	0.37	7.41_c	0.32
Women	1.64_a	0.34	5.05_b	0.43	7.56_c	0.43
			Arousal			
Men	6.23_a	0.55	2.89_b	0.54	6.11_a	0.59
Women	6.89_a	0.56	3.01_b	0.43	6.04_c	0.57

Note. Mean valence and arousal ratings for the International Affective Picture System pictures presented (ratings are from Lang, Bradley, & Cuthbert, 1999). Within a row, means with different subscripts are significantly different from one another ($p < .05$).

Hz was applied before integration and rectification of the raw EMG signals with a Coulbourn S76-01 contour following integrator (time constant = 20 ms). A PC running SnapStream software (HEM Data Corporation, Springfield, MI) and a 12-bit analog-to-digital board (Analogic Corporation, Wakefield, MA) was used to digitize and store signals at 250 Hz throughout picture presentation. Recording equipment was calibrated before and after each session. The units for raw and integrated EMG were microvolts.

Peak magnitude was scored in a window between 20 and 120 ms following probe onset by subtracting EMG activity at reflex onset for peak amplitude. Approximately 14.8% of eyeblink reflexes were excluded (treated as missing values) due to an unstable baseline (50 ms preceding probe onset) or because reflex onset was before 20 ms following probe onset. Trials with no perceptible eyeblink reflex were assigned a magnitude of zero and included in analysis. Within a participant, outliers greater than three standard deviations from that participant's mean were excluded. As mentioned earlier, 6 participants were dropped because they did not have at least three good startle responses of the nine possible for each cell in the design (Picture Condition $\times$ Probe Time).

Data Analysis

An initial omnibus repeated-measures multivariate analysis of variance (MANOVA) was conducted, with condition (unpleasant, neutral, pleasant) and probe time (warn, midpicture, 1.5-s intertrial interval [ITI], 3-s ITI, 6-s ITI) as within-subjects factors and group (anhedonic depression, anxious apprehension, anxious arousal, control) as a between-subjects variable. On the basis of a significant three-way interaction, subsequent Picture Condition $\times$ Group MANOVAs were calculated for each probe time to determine at what points in picture processing group differences in the emotion modulation of startle were present. Significant interactions for these analyses of variance were decomposed using appropriate simple effects analyses and pairwise contrasts (described in more detail later).

Results

Identification of Probe Times Reflecting Picture Condition $\times$ Group Interactions

Omnibus Picture Condition $\times$ Probe Time $\times$ Group MANOVA. The omnibus Picture Condition $\times$ Probe Time $\times$ Group MANOVA revealed a main effect for picture condition, $F(2, 77) = 13.96$, $p < .001$, $\eta^2 = .266$. As expected, both the valence-driven linear trend indicating unpleasant > neutral > pleasant blink magnitude, $F(1, 78) = 18.92$, $p < .001$, $\eta^2 = .195$, and the arousal-related quadratic trend indicating greater blink magnitude for affective relative to neutral pictures, $F(1, 78) = 26.52$, $p < .001$, $\eta^2 = .254$, were significant. There was also a main effect for probe time, $F(4, 75) = 3.43$, $p = .01$, $\eta^2 = .155$. Across picture condition and group, blink responses were larger for the 3-s ITI probe time than the 6-s ITI probe time, $t(81) = 3.51$, $p < .001$. In addition, probes during the warning stimulus elicited larger blinks than those at the 6-s ITI, $t(81) = 3.00$, $p < .005$. There was no main effect for group, $F(3, 78) = 1.56$, ns, $\eta^2 = .056$.

These main effects were qualified by significant Picture Condition $\times$ Probe Time, $F(8, 71) = 2.33$, $p < .03$, $\eta^2 = .208$, and Picture Condition $\times$ Probe Time $\times$ Group, $F(24, 219) = 1.76$, $p < .02$, $\eta^2 = .162$, interactions. Following up on these significant interactions, Picture Condition $\times$ Group MANOVAs were conducted for each of the five probe times. The condition main effect remained significant for all five probe times ($ps < .01$). Both the linear and quadratic trends, indicating significant effects for both picture valence and arousal level, were significant for the warn probe time, linear: $F(1, 78) = 10.93$, $p < .001$, $\eta^2 = .123$; quadratic: $F(1, 78) = 18.71$, $p < .001$, $\eta^2 = .219$ (see Nitschke et al., 2002, for further discussion of this finding), and the midpicture probe time, linear: $F(1, 78) = 9.60$, $p < .003$, $\eta^2 = .110$; quadratic: $F(1, 78) = 11.00$, $p < .001$, $\eta^2 = .124$. At 1.5-s ITI and 3-s ITI, only the arousal-related quadratic contrast reached significance, 1.5-s ITI: $F(1, 78) = 14.09$, $p < .001$, $\eta^2 = .153$; 3-s ITI: $F(1, 78) = 7.85$, $p = .006$, $\eta^2 = .091$.

Probe times showing Picture Condition $\times$ Group interaction. The Picture Condition $\times$ Group interaction was significant for the midpicture, $F(6, 156) = 3.21$, $p < .005$, $\eta^2 = .110$, and 1.5-s ITI probe times, $F(6, 156) = 2.77$, $p < .01$, $\eta^2 = .096$, but not for the warn, 3-s ITI, or 6-s ITI probe times ($ps > .25$). Two steps were taken to decompose these significant emotion modulation differences for the midpicture and 1.5–2 ITI probe times. First, t tests comparing group differences for unpleasant minus neutral and pleasant minus neutral difference scores were calculated. The t tests comparing each valence separately (e.g., responses to pleasant pictures) yielded the same pattern of results. Thus, for brevity only the contrasts between affective and neutral pictures are presented here. Comparisons that were not predicted a priori were Bonferroni corrected within each probe time. Second, we calculated within-subjects t tests for each group for the two emotion modulation contrasts at the midpicture and 1.5-s ITI probe times. Figures 1 and 2 depict the mean raw blink magnitudes for these two probe times.

Specific Group Differences in Emotion Modulation at Midpicture and 1.5-s ITI Probe Times

Unpleasant versus neutral modulation effects at the midpicture probe. During the midpicture period, no significant group differences were found for unpleasant compared with neutral pictures ($ps > .16$), including the a priori prediction that participants high on anxious arousal would show enhanced potentiation of startle blink, anxious arousal group versus control group: $t(47) = 1.00$, $p = .32$ (see Figure 1 for midpicture probe group means). Greater blink potentiation to unpleasant compared with neutral pictures was expected for all groups. This pattern was evident for the anxious arousal group, $t(9) = 3.50$, $p = .007$, along with a trend in this direction for the control group, $t(38) = 1.93$, $p = .06$, and the anhedonic depression group, $t(18) = 2.00$, $p < .06$. Blink magnitudes were not larger to unpleasant compared with neutral pictures for the anxious apprehension group, $p = .20$.

Pleasant versus neutral modulation effects at the midpicture probe. For the pleasant compared with neutral midpicture responses, we predicted decreased attenuation of blink magnitudes for participants with symptoms of anhedonic depression. This prediction was confirmed with the anhedonic depression group exhibiting significant reductions in blink attenuation compared with the control group, $t(56) = 2.14$, $p < .04$. In addition, decreased attenuation (larger blink magnitudes to pleasant compared
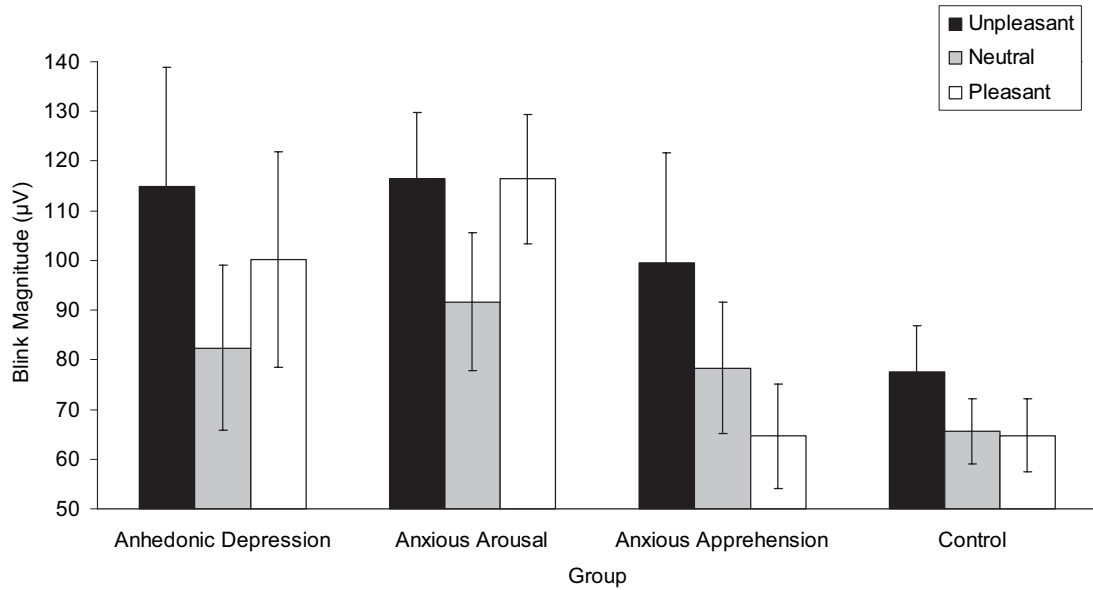
Figure 1. Mean blink magnitude ($\pm SE$) at the midpicture probe time (2-s postpicture onset) for unpleasant, neutral, and pleasant pictures for each of the four groups.

with neutral pictures) was also present for the anxious arousal group compared with the control group, $t(47) = 3.38$, $p < .05$ (corrected). The anxious apprehension group did not differ from the control group, $t(51) = 2.14$, $p > .05$ (corrected), and showed

more attenuation than the anhedonic depression group, $t(31) = 2.80$, $p < .02$ (corrected), and anxious arousal group, $t(22) = 4.10$, $p < .01$ (corrected). The only group to show significantly smaller blinks (attenuation) for pleasant than neutral pictures was the
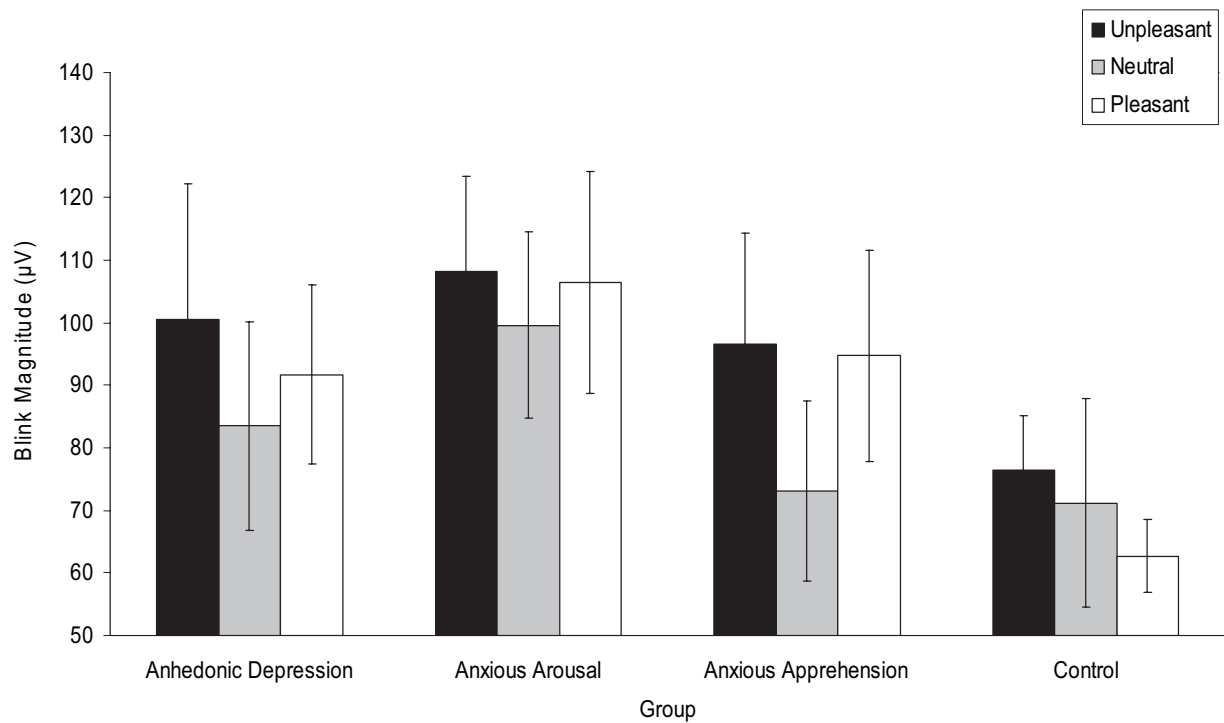

Figure 2. Mean blink magnitude ($\pm SE$) at the 1.5-s intertrial interval (ITI) probe time (1.5-s postpicture offset) for unpleasant, neutral, and pleasant pictures for each of the four groups.

anxious apprehension group, $t(13) = 2.73$, $p < .02$. The anxious arousal group actually showed larger blink magnitude (potentiation) for pleasant than neutral pictures, $t(9) = 2.87$, $p < .02$.

Unpleasant versus neutral modulation effects at the 1.5-s ITI probe. In keeping with the notion that depressed individuals are more likely to sustain negative affect, we predicted greater blink potentiation to unpleasant pictures following picture offset for participants with depressive symptoms. However, the potentiation observed for the anhedonic depression group at the 1.5-s ITI probe was not greater than for the control group, $t(56) = 1.37$, $p = .17$. Conversely, there was a trend for greater blink potentiation to unpleasant versus neutral pictures among the anxious apprehension group than the control group, $t(51) = 2.07$, $p < .04$ (uncorrected; see Figure 2). Potentiation of blinks to unpleasant compared with neutral stimuli was found for the anhedonic depression group, $t(18) = 2.08$, $p < .05$, and the anxious apprehension group, $t(13) = 2.88$, $p = .01$.

Pleasant versus neutral modulation effects at the 1.5-s ITI probe. With respect to pleasant compared with neutral stimuli, as predicted, the control group showed greater attenuation to pleasant pictures than did the anhedonic depression group, $t(56) = 2.27$, $p < .03$. In addition, the control group also showed greater attenuation postpicture than did the anxious apprehension group, $t(51) = 3.97$, $p < .001$ (corrected). As expected, the control group showed sustained attenuation of responses to pleasant relative to neutral stimuli, $t(38) = 2.20$, $p < .04$, which was not evident in any of the symptomatic groups. In fact, significant potentiation of blinks following pleasant versus neutral pictures was evident for the anxious apprehension group, $t(13) = 3.21$, $p < .007$.

Discussion

Common and Distinct Patterns of Affective Responding in Symptomatic Groups

As might be expected given the high comorbidity of depression and anxiety, there were substantial cross-group similarities in affective responding. Unpleasant pictures were unpleasant for everyone, including nonsymptomatic participants, as indicated by greater potentiation to those pictures than to neutral pictures. In addition, anticipation elicited potentiation of blink for everyone, in anticipation not just of aversive stimuli, but of pleasant stimuli as well (Nitschke et al., 2002). Furthermore, all symptomatic participants showed a lack of sustained positive affect (blink attenuation) following picture offset.

However, in addition to these commonalities, different symptom clusters did yield varying patterns of emotion-modulated responding. These group differences were limited to the period during and just following offset of the picture presentation, indicating that in the current paradigm any major differences between symptom groups in emotion modulation of startle were no longer evident by 3 s following picture offset. During picture viewing, participants exhibiting only anxious arousal symptoms showed potentiation for any emotional stimulus, unpleasant or pleasant. The mere presence of an affectively arousing stimulus potentiated blink responses. Those individuals high only on anxious apprehension showed a normal pattern of responding during the picture and exhibited potentiation to unpleasant as well as pleasant pictures just following picture offset. As expected, anhedonic depression was associ-

ated with a sustained blunted response to pleasant pictures. However, the sustained potentiation to unpleasant pictures in individuals high on anhedonic depression was not significantly different from control participants' responses to the unpleasant pictures. Thus, these symptom-specific groups can be differentiated to some degree by their responses during and just following viewing of picture affective pictures.

Implications for Understanding Affective Processes in Depression

Our data indicating a failure to sustain responses to pleasant stimuli in those with depressive symptoms is consistent with other research (Shestyuk et al., 2005). Although some work has found increased sadness and negative affect in response to pleasant stimuli (Dunn, Dalgleish, Lawrence, Cusack, & Ogilvie, 2004; Rottenberg et al., 2002), potentiation of startle blink in response to pleasant pictures in depression has been found to be limited to the most severe cases (Allen et al., 1999). Our finding of a lack of attenuation of startle blink, but not significant potentiation, during pleasant pictures is consistent with this, given that we assessed a nonclinical sample. However, with respect to negative affect, although the means for the depressed group do indicate continued potentiation of startle blink following unpleasant pictures relative to controls, this group difference did not reach significance. Thus, in our sample we did not replicate previous work suggesting sustained responding to unpleasant stimuli in depression (Deldin et al., 2001; Rottenberg et al., 2002; Siegle et al., 2001, 2002), although this may be a function of the small sample size. In addition, we also did not find that those high on anhedonic depression showed enhanced responses during the presentation of unpleasant stimuli compared with the other three groups. Although this may be a function of the narrowly defined depression group selected here, primarily the emphasis on anhedonia, there also seems to be mixed evidence for deficits in responding to negatively valenced stimuli in depression. A number of studies have found that individuals with depression exhibit deficits not only in responses to positively valenced stimuli, but to negatively valenced stimuli or events as well (Kaviani et al., 2004; Peeters, Nicolson, Berkhof, Delespaul, & deVries, 2003; Rottenberg et al., 2002). Other research has found no differences in responses to unpleasant stimuli in depressed people compared with controls (Dunn et al., 2004; Sloan et al., 2001). Thus, although deficits in responses to positive stimuli in depression seem robust, responses to negatively valenced stimuli have been found to be more variable. Indeed, Rottenberg, Gross, and Gotlib (2005) have proposed that depression may be characterized by diminished reactivity to both pleasant and unpleasant affective stimuli, suggesting an inherent deficit in adaptive context modulation of emotional responses.

Implications for Understanding Affective Processes in Anxiety

Neither anxiety group showed abnormally elevated responses to unpleasant stimuli during picture viewing. We had predicted that those individuals high on anxious arousal would exhibit stronger responses when faced with an aversive stimulus, whereas the potentiation observed was commensurate with that for the other

groups. Conversely, anxious arousal participants showed abnormal elevation of blink responses while viewing pleasant pictures. These individuals' responses were not differentiated by stimulus valence, rather any stimulus high on arousal elicited blink potentiation regardless of valence. These data suggest that the construct of anxious arousal may in fact not be specifically linked to enhanced responding to aversive or threatening events but rather a sensitivity to any affectively charged stimulus.

In contrast to the dysregulated responses during the picture for anxious arousal participants, the anxious apprehension participants showed normal emotion modulation of startle blink during the picture but potentiation of blink for both unpleasant and pleasant pictures after picture offset. We had originally predicted that anxious apprehension participants would show larger responses during the warning stimulus predicting unpleasant pictures. This was not apparent as the phenomenon of anticipation proved strong enough to elicit potentiation of startle among all groups for both unpleasant and pleasant stimuli, suggesting that anticipation of affective stimuli elicits some combination of increased arousal, increased NA, or both (Nitschke et al., 2002). However, the postpicture effects observed in the anxious apprehension group may reflect the type of future-oriented NA we predicted for these individuals. One possibility is that the offset of any affective stimulus, including pleasant stimuli, may precipitate the worry characteristic of participants with anxious apprehension. Although individuals who worry may be able to appropriately modulate their affective responses in the moment, as evidenced here, the termination of affective events may prompt anxiety about impending events. Measures of future-directed thinking have shown that anxious individuals show an increase in expectation of negative events in the future (MacLeod & Byrne, 1996; MacLeod, Byrne, & Valentine, 1996). Our data suggest that this expectancy bias may not be present in anxious individuals with predominantly arousal-related symptoms but instead is specific to those characterized by anxious apprehension.

Implications for Structural Models of Anxiety and Depression

The reformulated tripartite model of depression and anxiety (Mineka et al., 1998) posits a common factor, increased NA, for both types of symptoms, as well as distinct factors for depression (anhedonia) and various forms of anxiety, including the construct of anxious arousal studied here. The data from the present study are partially consistent with this model and also suggest that increased specificity regarding the time course of state-induced affect can help further delineate the structure of affect associated with symptoms of anxiety and depression. Consistent with the reformulated tripartite model, all groups showed heightened responses to unpleasant stimuli. As this was also true for nonsymptomatic participants, it may be that the state-related responses to unpleasant pictures engage the NA system in all individuals but do not capture the more traitlike NA associated with extended states of depression and anxiety. The data from the current study are also consistent with the tripartite model in that blunted responding to pleasant stimuli was observed for the anhedonic depression group. This was especially true following the offset of pleasant pictures, indicating that anhedonic depression may be particularly characterized by the failure to sustain positive affect.

In contrast to the specificity of positive affect deficits in depression posited by the tripartite model, our data suggest that anxious participants also had dysregulated responses to pleasant stimuli. Those high on anxious arousal showed potentiation of blink while viewing the appetitive pictures, suggesting that anxious arousal may be reflective of greater overall arousal, not valence-specific responses. In addition, like anhedonic depression, anxious apprehension was associated with failure to sustain positive affect. These data suggest that deficits in PA are not specific to depression. Other work has also pointed to PA deficits in anxiety (Beck et al., 2001; Brown et al., 1998; Kashdan, 2004; Kaviani et al., 2004; Shapiro, Roberts, & Beck, 1999; Watson, Clark, & Carey, 1988). Previous work in affective chronometry has also found that neuroticism is linked with the time course of not only NA, but PA as well. Similarly, extraversion influenced the time course of responses to both positive and negative stimuli (Hemenover, 2003). Indeed, Watson (2000) has suggested that low PA may not be specific to depression but can also be seen in other disorders, including posttraumatic stress disorder, eating disorders, substance use disorders, and schizophrenia. Consideration of the time course of affective responses along with specific dimensions of anxiety appears to be necessary to fully understand the role of PA in anxiety.

The original tripartite model was formulated on the basis of self-report measures that were not intended to assess the chronometry of state-related affect. The present data indicate that the use of measures sensitive to parameters of affective responding that are difficult to capture with self-report (i.e., the time course of affective responding) is important to fully capture the structure of affect associated with symptoms of anxiety and depression. More important, trait differences in mood may in part arise from variation in response to acute emotional events, and the time course of such state-related responses may be particularly relevant characteristics for determining traitlike mood.

Caveats

A number of caveats must be addressed. Although the initial sample size was large for a psychophysiological assessment, to maintain the integrity of group status by imposing symptom stability criteria the final sample sizes for some of the symptom groups were somewhat low. In particular, the anxious arousal group suffered a great deal of attrition due to the lack of stability between the first and second symptom assessments. It may be that anxious arousal is an inherently less stable trait, particularly if these symptoms are not acutely activated. With respect to depression, we examined a very specific subtype of depressive symptoms, those related to anhedonia. Although this subgroup was chosen on the basis of the tripartite model and these individuals also showed elevated general distress, it is possible that defining the group in this way had the effect of leading to more salient effects in response to pleasant compared with unpleasant stimuli.

With respect to the pleasant stimuli, we did not replicate the finding of attenuated blink response to pleasant compared with neutral pictures during picture viewing in the nonsymptomatic participants. Previous work has indicated that significant attenuation of blink responses occurs in response to pictures of erotica, but not necessarily for other pictures rated as pleasant (Bradley, Codispoti, Cuthbert, & Lang, 2001). Although the present para-

digm incorporated a small number of erotic stimuli, the pleasant stimuli were predominantly chosen from other categories, such as food, sports, and nature scenes. Also, we measured one index of affective responding, using snapshots of startle blink modulation at various points in time during stimulus processing. Use of continuous measures may provide richer information about the chronometry of affective responses associated with these symptoms. In addition, other types of stimuli may prove more suitable for eliciting both sustained affective reactions and feelings of apprehension or worry. Furthermore, some of the discrepancies in findings between the current study and previous work may be related to methodological differences. For example, emotion modulation of blink responses to affective pictures may not yield comparable results to ERP, functional MRI, or pupil dilation studies of responses to affective words or other stimuli.

Conclusions

These data highlight the interplay of positive and negative affective responses over time in both depression and anxiety. Our data support structural models of these distress symptoms that find depression and different forms of anxiety to have both common and unique components. However, they also point to complexities in cleanly distinguishing anxiety from depression on the basis of PA and NA. Depression seems to be less reliably associated with dysregulation of responding to unpleasant stimuli, and those with anxious symptoms are not immune to dysregulation of responses to pleasant stimuli. Furthermore, perturbations in PA and NA in anxiety and depression are not static; rather, they vary with the dynamics of the unfolding affective event. Clearly, a comprehensive understanding of the specific affective deficits in depression and anxiety must take into account the chronometry of affective responses.

References

Allen, N. B., Trinder, J., & Brennen, C. (1999). Affective startle modulation in clinical depression: Preliminary findings. *Biological Psychiatry, 46,* 542–550.

Andrews, V. H., & Borkovec, T. D. (1988). The differential effects of induction of worry, somatic anxiety, and depression on emotional experience. *Journal of Behavior Therapy and Experimental Psychiatry, 19,* 21–26.

Barlow, D. H. (1991). Disorders of emotion. *Psychological Inquiry, 2,* 58–71.

Beck, R., Perkins, T. S., Holder, R., Robbins, M., Gray, M., & Allison, S. H. (2001). The cognitive and emotional phenomenology of depression and anxiety: Are worry and hopelessness the cognitive correlates of NA and PA? *Cognitive Therapy and Research, 25,* 829–838.

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1,* 276–298.

Brown, T. A., Chorpita, B. F., & Barlow, D. H. (1998). Structural relationships among dimensions of the *DSM–IV* anxiety and mood disorders and dimensions of negative affect, positive affect, and autonomic arousal. *Journal of Abnormal Psychology, 107,* 179–192.

Center for the Study of Emotion and Attention. (1999). *The international affective picture system: Digitized photographs.* Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Clark, L. A., & Watson, D. (1991). Tripartite model of anxiety and depression: Psychometric evidence and taxonomic implications. *Journal of Abnormal Psychology, 100,* 316–336.

Cook, E. W., Davis, T. L., Hawk, L. W., & Spence, E. L. (1992). Fearfulness and startle potentiation during aversive visual stimuli. *Psychophysiology, 29,* 633–645.

Cook, E. W., Hawk, L. W., Davis, T. L., & Stevenson, V. E. (1991). Affective individual differences and startle reflex modulation. *Journal of Abnormal Psychology, 100,* 5–13.

Corr, P. J. (2002). J. A. Gray's reinforcement sensitivity theory: Tests of the joint subsystems hypothesis of anxiety and impulsivity. *Personality and Individual Differences, 33,* 511–532.

Corr, P. J., Kumari, V., Wilson, G. D., Checkley, S. A., & Gray, J. A. (1997). Harm avoidance and affective modulation of the startle reflex: A replication. *Personality and Individual Differences, 30,* 333–352.

Cuthbert, B. N., Lang, P. J., Strauss, C., Drobes, D. J., Patrick, C. J., & Bradley, M. M. (2003). The psychophysiology of anxiety disorder: Fear memory imagery. *Psychophysiology, 40,* 407–422.

Davidson, R. J. (1998). Affective style and affective disorders: Perspectives from affective neuroscience. *Cognition and Emotion, 12,* 307–320.

Davidson, R. J., Jackson, D. C., & Kalin, N. H. (2000). Emotion, plasticity, context, and regulation: Perspectives from affective neuroscience. *Psychological Bulletin, 126,* 890–909.

Deldin, P. J., Deveney, C. M., Kim, A. S., Casas, B. R., & Best, J. L. (2001). A slow wave investigation of working memory bias in mood disorders. *Journal of Abnormal Psychology, 110,* 267–281.

Deveney, C. M., & Deldin, P. J. (2004). Memory of faces: A slow wave ERP study of depression. *Emotion, 4,* 295–304.

Dichter, G. S., Tomarken, A. J., & Baucom, B. R. (2002). Startle modulation before, during and after exposure to emotional stimuli. *International Journal of Psychophysiology, 43,* 191–196.

Dichter, G. S., Tomarken, A. J., Shelton, R. C., & Sutton, S. K. (2004). Early- and late-onset startle modulation in unipolar depression. *Psychophysiology, 41,* 433–440.

Dunn, B. D., Dalgleish, T., Lawrence, A. D., Cusack, R., & Ogilvie, A. D. (2004). Categorical and dimensional reports of experienced affect to emotion-inducing pictures in emotion. *Journal of Abnormal Psychology, 113,* 654–660.

Forbes, E. E., Miller, A., Cohn, J. F., Fox, N. A., & Kovacs, M. (2005). Affect-modulated startle in adults with childhood-onset depression: Relations to bipolar course and number of lifetime depressive episodes. *Psychiatry Research, 134,* 11–25.

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.

Heller, W., Nitschke, J. B., Etienne, M. A., & Miller, G. A. (1997). Patterns of regional brain activity differentiate types of anxiety. *Journal of Abnormal Psychology, 106,* 376–385.

Hemenover, S. H. (2003). Individual differences in rate of affect change: Studies in affective chronometry. *Journal of Personality and Social Psychology, 85,* 121–131.

Jackson, D. C., Mueller, C., Dolski, I., Dalton, K. M., Nitschke, J. B., Urry, H. L., et al. (2003). Now you feel it, now you don't: Frontal brain electrical asymmetry and individual differences in emotion regulation. *Psychological Science, 14,* 612–617.

Kashdan, T. B. (2004). The neglected relationship between social interaction anxiety and hedonic deficits: Differentiation from depressive symptoms. *Journal of Anxiety Disorders, 18,* 719–730.

Kaviani, H., Gray, J. A., Checkley, S. A., Raven, P. W., Wilson, G. D., & Kumari, V. (2004). Affective modulation of the startle response in depression: Influence of the severity of depression, anhedonia, and anxiety. *Journal of Affective Disorders, 83,* 21–31.

Kessler, R. C., McGonagle, K. A., Zhao, S., Nelson, C. B., Hughes, M., Eshleman, S., et al. (1994). Lifetime and 12-month prevalence of *DSM–III–R* psychiatric disorders in the United States: Results from the National Comorbidity Survey. *Archives of General Psychiatry, 51,* 8–19.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1999). *International*

affective picture system: Technical manual and affective ratings. Gaines-ville, FL: Center for Research in Psychophysiology, University of Florida.

Larsen, D. K., Norton, G. R., Walker, J. R., & Stein, M. B. (2002). Analysis of startle responses in patients with panic disorder and social phobia. *Cognitive Behaviour Therapy, 31,* 156–169.

Larson, C. L., & Davidson, R. J. (2001). Prolonged startle blink potentiation following negative stimuli among individuals with relative right frontal EEG asymmetry. *Psychophysiology, 38,* S9.

MacLeod, A. K., & Byrne, A. (1996). Anxiety, depression, and the anticipation of future positive and negative experiences. *Journal of Abnormal Psychology, 105,* 286–289.

MacLeod, A. K., Byrne, A., & Valentine, J. D. (1996). Affect, emotional disorder, and future-directed thinking. *Cognition and Emotion, 10,* 69–86.

Meyer, T. J., Miller, M. L., Metzger, R. L., & Borkovec, T. D. (1990). Development and validation of the Penn State Worry Questionnaire. *Behavior Research and Therapy, 28,* 487–495.

Mineka, S., Watson, D., & Clark, L. A. (1998). Comorbidity of anxiety and unipolar mood disorders. *Annual Review of Psychology, 49,* 377–412.

Nitschke, J. B., Heller, W., Imig, J. C., McDonald, R. P., & Miller, G. A. (2001). Distinguishing dimensions of anxiety and depression. *Cognitive Therapy Research, 25,* 1–22.

Nitschke, J. B., Heller, W., & Miller, G. A. (2000). Anxiety, stress, and cortical brain function. In J. C. Borod (Ed.), *The neuropsychology of emotion* (pp. 298–319). New York: Oxford University Press.

Nitschke, J. B., Heller, W., Palmieri, P. A., & Miller, G. A. (1999). Contrasting patterns of brain activity in anxious apprehension and anxious arousal. *Psychophysiology, 36,* 628–637.

Nitschke, J. B., Larson, C. L., Smoller, M. J., Navin, S. D., Pederson, A. J. C., Ruffalo, D., et al. (2002). Startle potentiation in anticipatory anxiety: Evidence for state but not trait effects. *Psychophysiology, 39,* 254–258.

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100,* 569–582.

Nolen-Hoeksema, S., Morrow, J., & Fredrickson, B. L. (1993). Response styles and the duration of episodes of depressed mood. *Journal of Abnormal Psychology, 102,* 20–28.

Peeters, F., Nicolson, N. A., Berkhof, J., Delespaul, P., & deVries, M. (2003). Effects of daily events on mood states in major depressive disorder. *Journal of Abnormal Psychology, 112,* 203–211.

Rottenberg, J., Gross, J. J., & Gotlib, I. H. (2005). Emotion context insensitivity in major depressive disorder. *Journal of Abnormal Psychology, 114,* 627–639.

Rottenberg, J., Kasch, K. L., Gross, J. J., & Gotlib, I. H. (2002). Sadness and amusement reactivity differentially predict concurrent and prospective functioning in major depressive disorder. *Emotion, 2,* 135–146.

Schimmack, U., Oishi, S., Diener, E., & Suh, E. (2000). Facets of affective experiences: A framework for investigations of trait affect. *Personality and Social Psychology Bulletin, 26,* 655–668.

Shapiro, A. M., Roberts, J. E., & Beck, J. G. (1999). Differentiating symptoms of anxiety and depression in older adults: Distinct cognitive and affective profiles? *Cognitive Therapy and Research, 23,* 53–74.

Shestyuk, A. Y., Deldin, P. J., Brand, J. E., & Deveney, C. M. (2005). Reduced sustained brain activity during processing of positive emotional stimuli in major depression. *Biological Psychiatry, 57,* 1089–1096.

Shuls, J., Green, P., & Hillis, S. (1998). Emotional reactivity to everyday problems, affective inertia, and neuroticism. *Personality and Social Psychology Bulletin, 24,* 127–136.

Siegle, G. J., Granholm, E., Ingram, R. E., & Matt, G. E. (2001). Pupillary response and reaction time measures of sustained processing of negative information in depression. *Biological Psychiatry, 49,* 624–636.

Siegle, G. J., Steinhauer, S. R., Carter, C. S., Ramel, W., & Thase, M. E. (2003). Do the seconds turn into hours? Relationships between sustained pupil dilation in response to emotional information and self-reported rumination. *Cognitive Therapy and Research, 27,* 365–383.

Siegle, G. J., Steinhauer, S. R., Thase, M. E., Stenger, V. A., & Carter, C. S. (2002). Can't shake that feeling: Event-related fMRI assessment of sustained amygdala activity in response to emotional information in depressed individuals. *Biological Psychiatry, 51,* 693–707.

Sirota, A. D., Schwartz, G. E., & Kristeller, J. L. (1987). Facial muscle activity during induced mood states: Differential growth and carry-over of elated versus depressed patterns. *Psychophysiology, 24,* 691–699.

Sloan, D. M., Bradley, M. M., Dimoulas, E., & Lang, P. J. (2002). Looking at facial expressions: Dysphoria and facial EMG. *Biological Psychology, 60,* 79–90.

Sloan, D. M., Strauss, M. E., Quirk, S. W., & Stajatovic, M. (1997). Subjective and expressive emotional responses in depression. *Journal of Affective Disorders, 46,* 135–141.

Sloan, D. M., Strauss, M. E., & Wisner, K. L. (2001). Diminished response to pleasant stimuli by depressed women. *Journal of Abnormal Psychology, 110,* 488–493.

Spasojevic, J., & Alloy, L. B. (2001). Rumination as a common mechanism relating depressive risk factors to depression. *Emotion, 1,* 25–37.

van Boxtel, A., Boelhouwer, A. J. W., & Bos, A. R. (1998). Optimal EMG signal and bandwidth and interelectrode distance for the recording of acoustic, electrocutaneous and photic blink reflexes. *Psychophysiology, 35,* 690–697.

Watson, D. (2000). *Mood and temperament.* New York: Guilford Press.

Watson, D., Clark, L. A., & Carey, G. (1988). Positive and negative affectivity and their relation to anxiety and depressive disorders. *Journal of Abnormal Psychology, 97,* 346–353.

Watson, D., Clark, L. A., Weber, K., Assenheimer, J. S., Strauss, M. E., & McCormick, C. M. (1995). Testing a tripartite model: II. Exploring the symptom structure of anxiety and depression in student, adult, and patient samples. *Journal of Abnormal Psychology, 104,* 15–25.

Watson, D., Weber, K., Assenheimer, J. S., Clark, L. A., Strauss, M. E., & McCormick, C. M. (1995). Testing a tripartite model: I. Evaluating the convergent and discriminant validity of anxiety and depression symptom scales. *Journal of Abnormal Psychology, 104,* 3–14.

Wilson, G. D., Kumari, V., Gray, J. A., & Corr, P. J. (2000). The role of neuroticism in startle reactions to fearful and disgusting stimuli. *Personality and Individual Differences, 29,* 1077–1082.

Zimmerman, M., McDermut, W., & Mattia, J. I. (2000). Frequency of anxiety disorders in psychiatric outpatients with major depressive disorder. *American Journal of Psychiatry, 157,* 1337–1340.

Zinbarg, R. E., & Barlow, D. H. (1996). Structure of anxiety and the anxiety disorders: A hierarchical model. *Journal of Abnormal Psychology, 105,* 181–193.