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Biased Processing of Emotional Information in Girls at Risk for Depression

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Researchers have documented that children of depressed mothers are at elevated risk for developing a depressive disorder themselves. There is currently little understanding, however, of what factors place these children at elevated risk. In the present study, the authors investigated whether never-disordered daughters whose mothers have experienced recurrent episodes of depression during their daughters' lifetime are characterized by biased processing of emotional information. Following a negative mood induction, participants completed an emotional-faces dot-probe task. Daughters at elevated risk for depression, but not control daughters of never-disordered mothers, selectively attended to negative facial expressions. In contrast, only control daughters selectively attended to positive facial expressions. These results provide support for cognitive vulnerability models of depression.

Keywords: depression, vulnerability, bias, attention, children

Given the high prevalence and the personal and societal costs of major depressive disorder (MDD), efforts to identify vulnerability factors for the onset of this disorder are particularly pressing. In addition to examining characteristics of individuals who are currently depressed, investigators have been focusing increasingly on factors associated with *risk* for MDD. Children of parents with depressive disorders are known to be at elevated risk for experiencing depressive episodes themselves (e.g., Gotlib & Goodman, 1999; Hammen, 1990); in fact, having parents who have experienced MDD is associated with a threefold increase in the an individual's risk for developing a depressive episode during adolescence (Hammen, 1997; Williamson, Birmaher, Axelson, Ryan, & Dahl, 2004). Moreover, maternal depression has been found to be associated with an earlier onset and more severe course of depression in the offspring (Lieb, Isensee, Hofler, Pfister, & Wittchen, 2002; for a recent review see Gotlib, Joormann, Minor, & Cooney, 2006). Given these findings, the assessment of offspring of depressed parents has been an important strategy for elucidating vulnerability factors for depression (Duffy, 2000).

Although researchers have clearly demonstrated that children of depressed mothers are at increased risk for experiencing depression themselves, the mechanisms underlying this risk are not well understood. Over the past 2 decades, cognitive models of depression have been developed to understand the etiology of MDD and vulnerability to this disorder (e.g., Beck, 1967; Teasdale, 1988). Cognitive theories posit that depressed individuals and persons who are vulnerable to experiencing depression selectively attend to negative stimuli, filter out positive stimuli, and demonstrate better recall for negative material than for neutral or positive material. In essence, cognitive models propose a diathesis–stress formulation in which stressful life events or negative mood states can trigger pre-existing latent maladaptive schemas, leading to biased processing of emotional material and depressive episodes. Numerous studies of depressed adults have provided support for the basic tenets of cognitive formulations of depression (see Gotlib & Krasnoperova, 1998, and Whitehouse, Turanski, & Murray, 2000, for reviews). It is important to note that recent investigations that have included a priming strategy, such as a negative mood induction, have demonstrated that biases in attention and memory can be activated following recovery from depression, suggesting that biased processing of emotional information is not simply a symptom of depression (e.g., Gilboa & Gotlib, 1997; Scher, Ingram, & Segal, 2005).

Unfortunately, research on information-processing biases in depressed children and in children at risk for depression lags behind investigations of depressed adults. Researchers have focused primarily on depressed children's memory for positive and negative information (e.g., Bishop, Dalgleish, & Yule, 2004). The results of these studies suggest that depressed children are similar to depressed adults with respect to biases in their memory for emotional material. In contrast, few researchers have examined biases in attentional functioning in depressed children, and most have not found evidence of an attentional bias toward negative words in this population (e.g., Dalgleish et al., 2003; Neshat-Doost, Moradi, Taghavi, Yule, & Dalgleish, 2000). These findings are consistent with the generally inconclusive results of studies investigating attentional biases in depressed adults (see Mogg & Bradley, 2005, for a review). Recently, however, Mogg and Bradley (2005) suggested that depression is not associated with rapid orienting toward

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negative stimuli but, rather, with difficulties disengaging from salient negative material that is presented at prolonged exposure durations (see also Mathews & MacLeod, 2005). Thus, studies using attentional tasks in depression might yield more consistent results if researchers used longer stimulus exposure durations and stimuli that are salient to the depressed participants. In this context, it is important to note that most studies of attentional bias in depressed children have used words as stimuli. Recently, however, Ladouceur et al. (2005) found that whereas children diagnosed with MDD were more easily distracted by negative pictures than by neutral pictures, control children were more easily distracted by positive pictures than by neutral pictures, suggesting that differences in stimulus materials might be contributing to the inconsistent findings of studies with children.

Of course, examining either adults or children who are currently depressed does not address the question concerning the role of biased processing of emotional material in the onset of depression. Cognitive theorists posit that such schema-driven biases precede the onset of depressive episodes and, therefore, should be evident in vulnerable individuals before they have experienced an episode of depression. To date, however, few researchers have examined this formulation. Although some investigators have used self-report measures to obtain evidence of negative cognitions, reduced self-worth, and dysfunctional attributional styles in children at elevated risk for depression (e.g., Garber & Robinson, 1997), few researchers have used experimental tasks to assess biases in the processing of emotional information in this population. In one of the first information-processing studies to include a group of high-risk children, Jaenicke et al. (1987) found that children of depressed mothers remembered proportionally fewer positive adjectives than did children of medically ill mothers or of mothers with no disorders; there were no group differences in the proportion of negative adjectives recalled. Similarly, Taylor and Ingram (1999) assessed the self-referent processing and subsequent recall of positive and negative words in children of parents with and without MDD. It is important to note that Taylor and Ingram administered a negative mood induction to half of the participants in each group, and in the absence of a sad mood induction, Taylor and Ingram found no differences between the low-risk and high-risk children. Under the mood-induction condition, however, the high-risk children exhibited diminished processing of positive self-referent words and greater recall of negative words.

Although these findings suggest that biased processing of emotional stimuli represents a risk factor for depression, it is important to note that neither Jaenicke et al. (1987) nor Taylor and Ingram (1999) excluded children who had already experienced a depressive episode. Jaenicke et al. reported that many of their participants had had past diagnosable episodes, and Taylor and Ingram did not obtain diagnostic information about the children. Consequently, it is impossible to determine whether the biases obtained in these studies represent vulnerability to depression or, alternatively, are consequences of having had a depressive episode (Barnett & Gotlib, 1988; Just, Abramson, & Alloy, 2001). In addition, Taylor and Ingram's results clearly underscore the importance of using a priming procedure in investigations of children at risk for depression. Indeed, in recent work examining cognitive factors associated with vulnerability to depression, it has become apparent that cognitive models of depression are explicitly diathesis–stress models (Monroe & Simons, 1991). A key assumption of these models is that individuals who are vulnerable to depression are characterized by potentially depressogenic schemas that are not activated until they are triggered by a negative event or negative mood state (e.g., Scher et al., 2005; Segal & Ingram, 1994). In the absence of schema activation, therefore, people with and without depressive schemas will perform similarly on measures of information processing and negative cognitions. Consequently, most contemporary researchers examining these hypotheses now use negative mood inductions to activate schemas before assessing cognitive functioning, under the rationale that these procedures create negative mood states that are similar to mood states that are the consequence of stressful life events (Scher et al., 2005).

The present study was designed to examine biases in the processing of emotional information in a sample of high-risk children who have no current or past diagnosis of depression or of any other Axis I disorder. Although other investigators have examined memory biases in children of depressed parents, no researcher to date has investigated whether children of depressed parents are characterized by selective attention to emotional stimuli. In the present study, therefore, we assessed biases in attention to emotional stimuli in carefully diagnosed, never-disordered daughters of mothers who have experienced recurrent depressive episodes during their daughter's lifetime. Drawing on diathesis–stress models of depression, we used a negative mood-induction procedure to prime maladaptive schemas prior to the assessment of cognitive biases and compared the functioning of these girls to that of never-disordered daughters of mothers with no history of psychopathology.

To assess biases in attention, we used a task that has frequently been used with adults: the dot-probe task. In this task, participants are presented with a pair of stimuli (words or faces) consisting of one neutral stimulus and one emotional stimulus. After the offset of these stimuli, a dot probe appears in the location of either the neutral stimulus or the emotional stimulus. Allocation of attention is assessed by participants' latency to detect the probe. If participants orient toward the emotional stimulus, they will more quickly detect probes that replace that stimulus (Mathews & MacLeod, 1986). As we noted above, Mogg and Bradley (2005) suggested that attentional biases might be observed more consistently in depression if investigators used longer stimuli exposure durations and more salient stimuli. In this context, it is important to note that studies of depressed adults suggest that facial expressions of emotions lead to more consistent results than do verbal stimuli (e.g., Gotlib, Kasch, et al., 2004; Gotlib, Krasnoperova, Yue, & Joormann, 2004). In the present study, therefore, we used a version of the dot-probe task with faces expressing sadness and happiness as stimuli. Pine et al. (2005) recently demonstrated the utility of this task in research with children at risk for emotional disorders, reporting that an attentional bias away from threatening faces was associated with severity of physical abuse and with a diagnosis of posttraumatic stress disorder in maltreated children. We predicted that whereas never-disordered daughters of recurrent depressed mothers would selectively attend to sad but not to happy facial expressions, never-disordered daughters of never-disordered mothers would attend selectively to happy but not to sad facial expressions.

Method

Participants

Participants were 41 girls, aged between 9 and 14 years, with no history of any Axis I disorder or psychosis. We recruited participants in this age group (a) because girls younger than 9 are likely to have difficulties with the task instructions, and (b) because daughters older than 14 who have depressed mothers are likely to have experienced a depressive episode themselves (Angold, Costello, & Worthman, 1998). Twenty girls had biological mothers with no history of any Axis I disorder, and 21 girls had biological mothers with a history of recurrent MDD during their daughter's lifetime. Participants were recruited through advertisements posted in numerous locations within the local community (e.g., Internet bulletin boards, university kiosks, supermarkets). The mothers' responses to a telephone interview provided initial selection information. This phone screen established that both mothers and daughters were fluent in English and that daughters were between 9 and 14 years of age. Daughters were excluded if they had experienced severe head trauma, if they had learning disabilities, or if they had current or past depression. This telephone interview was also used to identify mothers who were likely either to have no psychiatric history or to meet criteria for recurrent depression during their daughter's lifetime. Those mother–daughter pairs who were considered likely to be eligible for participation were invited to come to the laboratory for more extensive interviews.

Assessment of Depression

At the interview session, trained interviewers assessed the diagnostic status of daughters by administering the Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime version (K-SADS-PL; Kaufman, Birmaher, Brent, Ryan, & Rao, 2000) separately to the daughters and to their mothers (about the daughters). The full interview, assessing current and lifetime diagnoses for affective, psychotic, anxiety, behavioral, substance abuse, and eating disorders was administered. Because of time constraints, and because we were interviewing only girls, the Tic Disorders and ADHD screeners were not administered (both of these disorders are more prevalent in boys; Gadow, Nolan, Sprafkin, & Schwartz, 2002). The K-SADS-PL has been shown to generate reliable and valid child psychiatric diagnoses (Kaufman et al., 1997). For each dyad, immediately following the interview with the mother, the interviewer administered the K-SADS-PL to the daughter.

A different interviewer administered the Structured Clinical Interview for the *DSM–IV* (SCID; First, Spitzer, Gibbon, & Williams, 1995) to the mothers. The SCID has demonstrated good reliability for the majority of the disorders covered in the interview (Skre, Onstad, Torgersen, & Kringlen, 1991; Williams et al., 1992). Both K-SADS-PL and SCID-I interviewers had previous experience with administering structured clinical interviews and were trained specifically to administer these interviews. To assess interrater reliability, an independent trained rater who was blind to group membership evaluated 30% of our SCID and K-SAD-PL interviews by randomly selecting audiotapes of equal numbers of at-risk and control pairs. In all cases, diagnoses of former depressive episodes in mothers, no history of depressive episodes in mothers, and absence of any current or previous Axis I disorder in the girls matched the diagnosis made by the original interviewer ($\kappa = 1.00$.) This indicates excellent interrater reliability, although we should note that the interviewers used the "skip-out" strategy, which may have reduced the opportunities for the independent rater to disagree with the diagnoses.

Daughters in the high-risk group (RSK) were eligible to participate in the study if (a) they did not meet criteria for any past or current Axis I disorder according to both the parent and child K-SADS-PL and if they did not meet the recommended cutoff score for clinical depression on the Children's Depression Inventory (Kovacs, 1985; see below) and (b) their mothers met the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., *DSM–IV*; American Psychiatric Association, 1994) criteria for at least two distinct episodes of MDD since the birth of their daughters but did not currently meet criteria for MDD. In addition, mothers in the high-risk group were included only if they had no current diagnosis of any Axis I disorder, although they could have a past diagnosis. Daughters in the healthy control group (CTL) were eligible to participate if (a) they did not meet criteria for any past or current Axis I disorder based on both the parent and child K-SADS-PL and (b) their mothers did not meet criteria for any Axis I disorder during the daughter's lifetime.

Questionnaires

Depression and anxiety symptoms. Daughters completed the 10-item version of the Children's Depression Inventory (CDI-S; Kovacs, 1985), a self-report measure of depressive symptomatology for children between the ages of 8 and 17 years. The CDI-S is derived from the 27-item Children's Depression Inventory; the long and short forms have generally been found to yield comparable results (Kovacs, 1992). This measure is based on functioning during the past 2 weeks, and each item is scored on a 3-point scale. A cutoff score of 8 is suggested to identify potentially clinically depressed individuals (Kovacs, 1985). As noted above, girls were included in the study only if they did not meet this cutoff score. Studies have shown good reliability and validity of the CDI-S (Kovacs, 1985, 1992). Daughters also completed the Multidimensional Anxiety Scale for Children (MASC; March, 1997), a 39-item screening questionnaire for anxiety problems in children and adolescents between the ages of 8 and 19 years. Studies have shown good reliability and validity of the MASC (March, Parker, Sullivan, & Stallings, 1997). Mothers completed the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), a 21-item, self-report measure of the severity of depressive symptoms. The reliability and validity of the BDI-II have been well documented (Beck et al., 1996).

Mood ratings. Daughters completed mood rating sheets to assess affect before and after the mood inductions associated with the information-processing tasks (see below). Ratings were made on a 5-point scale consisting of drawn face pictures, ranging from 1 (*very sad*) to 5 (*very happy*). This mood manipulation check has been used successfully by several other investigators (e.g., Barden, Garber, Duncan, & Masters, 1981; Taylor & Ingram, 1999).

Verbal intelligence. The vocabulary section of the verbal subtest of the Wechsler Intelligence Scale for Children–IV (Wechsler, 2003) was administered to the daughters to assess knowledge of word meanings and language development and to ensure that any group differences in the processing of emotional information were not a function of group differences in intellectual ability.

Mood Inductions

A meta-analysis of mood-induction studies conducted with adults concluded that film clips with explicit instructions to enter a specific mood state are the most effective form of induction (Westermann, Spies, Stahl, & Hesse, 1996). It is important to note that Silverman (1986) analyzed studies using mood inductions in children and concluded that methodologies used to induce a negative mood state in adults are also effective in children. Thus, brief film clips were used to induce a negative mood state in the daughters before each of the information-processing tasks (dot-probe task and self-referential encoding task,[1] see below). *Stepmom* (Columbus, 1998) depicts a young son and adolescent daughter saying goodbye to their terminally ill mother. *My Girl* (Zieff, 1991) depicts an adolescent girl learning that her best friend has died. *Dead Poets Society* (Weir, 1989) depicts an adolescent boy learning that his best friend has committed suicide. *The Champ* (Zeffirelli, 1979) depicts a young boy watching his father die in a hospital room. A positive mood clip was shown after the information-processing tasks were completed. This film clip was from *Milo and Otis* (Hata, 1989), and it depicted puppies and kittens playing in a field. Each film clip was approximately 6 min long and was preceded by instructions to watch the clip carefully and to imagine being in the situation presented. Following the film clip, guided imagery was presented for 2 min instructing the participants to think about how they would feel if they experienced the situation they had just viewed.

Dot-Probe Task

Stimuli. A set of 12 faces, each expressing happy, sad, and neutral emotions, was selected from the MacArthur Network Face Stimuli Set (http://www.macbrain.org/faces/index.htm),[2] developed by The Research Network on Early Experience and Brain Development. The entire MacArthur Network Face Stimuli Set consists of color photographs of 646 different facial-expression stimuli displayed by a variety of models across different genders and ethnicities. For the current study, we selected from this validated set of face stimuli (Tottenham, Borscheid, Ellertsen, Marcus, & Nelson, 2002) an equal number of male and female faces that each had a neutral, happy, and sad expression, as well as an equal number of faces of different ethnicities.

Design and procedure. Each of the picture pairs (12 happy and 12 sad expressions paired with the neutral expression of the same actor) was presented four times, for a total of 96 trials, which were divided into two blocks with a 1-min rest period between them. The trials were presented in a new, fully randomized order for each subject. Each trial began with the display of a white fixation cross in the middle of the screen for 1,000 ms, followed by the presentation of a face pair on the screen for 1,500 ms. Following the offset of the pictures, a small gray dot appeared in the center of the screen location where one of the pictures had been and remained on the screen until the participant pressed a key on the keyboard. The emotional stimulus faces (sad or happy) appeared in the right and the left positions with equal probability, with the matched neutral face of each pair appearing in the other position. The dot probe was also presented in both positions with equal probability. When projected on the screen, the size of each picture was approximately 9 cm × 10 cm. The pictures in each pair were approximately 13 cm apart (measured from their centers). The task was presented on an IBM-compatible computer and a Dell 17-in. (43.18-cm) color monitor. E-Prime (Psychology Software Tools, 2002) software was used to control stimulus presentation and record response accuracy and latency.

Participants were seated in front of the computer, with the index finger of their left hand on the "Z" key, which was labeled "L" for left, and the index finger of their right hand on the "M" key, which was labeled "R" for right. Participants were told that their goal in this task was to respond as quickly and as accurately as possible when they detected a small dot by pressing the key labeled "L" if the dot appeared on the left side of the screen and the key labeled "R" if the dot appeared on the right side. Participants first completed 10 practice trials: 6 with just a dot presented and 4 with the faces presented followed by the dot. When the participants felt comfortable with the procedure, the experimenter left the room and the participants completed all 96 test trials of the task on their own.

Overall Procedure

All participants took part in the clinical interviews and completed the questionnaires following the interviews. If eligible, the daughters participated in the information-processing tasks. Participants were told that the experiment was designed to assess how they process emotional information. The information-processing session started with a mood measurement followed by the first mood induction and a second mood assessment. This was followed by either the dot-probe task or the self-referential encoding task. After the daughters completed the first task, another mood-induction film clip was presented and mood was reassessed. This was followed by the second task. Finally, the positive mood-induction film clip was presented and a final mood measurement was conducted. At the end of the session, the daughters completed the Wechsler Intelligence Scale for Children–IV Vocabulary subscale. The film clips were randomly selected for every participant, and the orders of the film clips and the two information-processing tasks were counterbalanced. The interview session lasted about 2 hr, and the information-processing tasks lasted about 45 min. Mother–daughter pairs were paid $25 per hour for their participation in the study.

Results

Participant Characteristics

Demographic and clinical characteristics of the two participant groups are presented in Table 1. There were no significant group differences in age, $t(39) < 1$, *ns*; Wechsler Intelligence Scale for Children–IV subtest scores; MASC scores, both $t(39) < 1$, *ns*; or

[1] We present only the results from the dot-probe task in this article.

[2] Development of the MacArthur Network Face Stimuli Set was overseen by Nim Tottenham and was supported by the John D. and Catherine T. MacArthur Foundation Research Network on Early Experience and Brain Development. Please contact Nim Tottenham at tott0006@tc.umn.edu for more information concerning the stimulus set.

ethnicity, $\chi^2(4, N = 41) = 5.75$, *ns*; the RSK girls obtained slightly but significantly higher scores on the CDI-S than did the CTL girls, $t(39) = 2.86$, $p < .05$. In addition, although they did not meet diagnostic criteria for current MDD, the mothers of the RSK girls obtained significantly higher BDI scores than did the mothers of the CTL girls, $t(39) = 4.01$, $p < .05$. Finally, although none of the mothers had a current diagnosis of an Axis I disorder, 6 of the mothers in the high-risk group were diagnosed with a past disorder besides MDD: 2 with obsessive-compulsive disorder, 2 with post-traumatic stress disorder, and 2 with an eating disorder.

Mood Induction

To examine the effectiveness of the mood-induction procedure, we conducted a repeated measures analysis of variance (ANOVA) on the mood ratings, with group (RSK, CTL) as the between-subjects factor and time (before mood induction, before first information-processing task, before second information-processing task, and at the end of the session) as the within-subject factor. This ANOVA yielded a significant main effect of time, $F(3, 117) = 65.05$, $p < .01$, but no main effect of group, $F(1, 39) < 1$, *ns*, and no Group × Time interaction, $Fs(3, 117) < 1$, *ns*.[3] The means of the mood ratings are presented in Table 2. Follow-up tests indicated that the participants rated their mood as significantly more positive before the mood inductions than they did after the mood inductions, $t(40) = 9.24$, $p < .01$, when comparing baseline mood ratings to the mood ratings before the dot-probe task, $t(40) = 7.78$, $p < .01$. Moreover, all participants rated their mood as significantly improved after the positive mood induction at the end of the session, $t(40) = 9.74$, $p < .01$, when comparing the mood rating before the dot probe to the mood ratings at the end of the session, $t(40) = 9.08$, $p < .01$. Thus, the mood inductions were equally effective in both participant groups.

Dot-Probe Task

Data-reduction procedures. Only response latencies from correct responses were analyzed. Error rates were extremely low (less than 1%) and did not differ between the groups, $t(38) < 1$. The two groups also did not differ with respect to average overall reaction times, $t(38) < 1$. To minimize the influence of outliers, we considered reaction times that were less than 100 ms to be anticipation errors and excluded them from the analyses. Similarly, reaction times that were greater than 1,000 ms were excluded because they were extremely infrequent and likely reflected lapses of concentration. Overall, the exclusion of these extreme reaction times resulted in the deletion of less than 1% of the data for participants in the two groups. The groups did not differ in the number of reaction times that were excluded, $t(38) < 1$. The data of 1 control participant were excluded because of a significant number of missing values. Average reaction times were computed for each group separately for each emotion type in the different conditions (same [probe is in the same location as the emotional face] vs. different [probe is in the other location from the emotional face]). The average reaction times for each condition are presented in Table 2. To test Hypothesis 2, we computed attentional bias scores separately for each facial expression (happy, sad), using the following equation (cf. Mogg, Bradley, & Williams, 1995):

$$\text{Attentional bias score} = 1/2\,[(\text{RpLe} - \text{RpRe}) + (\text{LpRe} - \text{LpLe})],$$

Table 1
Characteristics of Participants

Characteristic	RSK ($n = 21$) *M*	RSK *SD*	RSK %	CTRL ($n = 20$) *M*	CTRL *SD*	CTRL %
Caucasian			72			75
Age (years)	12.43	1.77_a		12.05	1.38_a	
WISC-IV	51.64	6.87_a		51.62	5.61_a	
CDI-S	2.76	1.84_a		1.25	1.52_b	
MASC	36.47	12.13_a		32.87	10.86_a	
BDI-II (mother)	12.40	10.86_a		2.41	4.55_b	

Note. Means having the same subscript are not significantly different at $p < .05$. RSK = daughters of formerly depressed mothers; CTRL = control participants; WISC-IV = Wechsler Intelligence Scale for Children–IV; CDI-S = Child Depression Inventory; MASC = Multidimensional Anxiety Scale for Children; BDI-II = Beck Depression Inventory–II.

Table 2
Mean Mood Ratings Before and After Mood Inductions and Mean Reaction Times in Dot-Probe Task by Group

Measure	CTL *M*	CTL *SD*	RSK *M*	RSK *SD*
Mood				
Before MI	4.30	0.57	4.00	0.63
Before dot probe	2.55	1.23	2.52	1.07
End of session	4.55	0.51	4.43	0.68
Dot probe (ms)				
Same: sad	481	71	484	89
Different: sad	481	66	495	93
Same: happy	479	72	491	89
Different: happy	494	76	491	82

Note. $N = 41$. CTL = control group; RSK = at-risk group; MI = mood induction; same = probe in same location as emotional face; different = probe in different location than emotional face.

[3] Because our previous analysis yielded significant group differences in CDI-S scores, we included the CDI-S as a covariate in all of our following analyses. Overall, the CDI-S scores did not change the pattern of our findings. The ANCOVA for the mood ratings yielded a significant main effect of time, $F(3, 114) = 30.23$, $p < .01$, but no main effect of group, $F(1, 39) < 1$, *ns*, and no Group × Time interaction, all $Fs(3, 114) < 1$, *ns*. The ANCOVA for the dot-probe bias scores yielded the predicted two-way interaction of Group × Face Emotion, $F(1, 37) = 6.89$, $p < .01$. There were no other significant main effects or interactions, all $Fs\,(1, 37) < 1$, *ns*. We also conducted an ANCOVA including the MASC scores as a covariate. This, too, did not alter our findings. The ANCOVA yielded the predicted two-way interaction of Group × Face Emotion, $F(1, 37) = 9.28$, $p < .01$. Follow-up tests yielded significant group differences for the negative faces, $F(1, 37) = 4.22$, $p < .05$, and for the positive faces, $F(1, 37) = 5.24$, $p < .05$, and no effects for the covariate.

where R = right position, L = left position, p = probe, and e = emotional face. In this equation, RpLe corresponds to the mean latency when the probe is in the right position and the emotional face is in the left position, and so on. This equation calculates the attention-capturing quality of emotional faces by subtracting the mean probe-detection times for probes appearing in the same position as the emotional face from the mean probe-detection times for probes appearing in a different position than the emotional face. Positive values of this bias score indicate a shift of attention toward the spatial location of emotional faces relative to matched neutral faces, and negative values indicate a shift of attention away from the spatial location of emotional faces relative to matched neutral faces.

Analyses. To test the hypothesis that whereas daughters of depressed mothers will selectively attend to sad but not to happy facial expressions, daughters of control mothers will selectively attend to happy but not to sad facial expressions, we conducted a two-way (Group × Face Emotion) repeated measures ANOVA on the bias scores of the RSK and CTL participants for sad and happy faces. This ANOVA yielded the predicted two-way interaction of Group × Face Emotion, $F(1, 38) = 7.75$, $p < .01$. There were no other significant main effects or interactions, all $Fs(1, 38) < 1$, *ns*. Follow-up tests yielded significant group differences in the bias scores for both sad faces, $t(38) = 2.05$, $p < .05$, and happy faces, $t(38) = 2.32$, $p < .05$. The group difference in the bias score for the happy faces translates into an effect size of $d = .70$, whereas the group difference in the bias score for sad faces translates into an effect size of $d = .67$, both medium to large effects (Cohen, 1988). As illustrated in Figure 1, as predicted, the RSK (but not the CTL) girls selectively attended to sad faces, whereas the CTL (but not the RSK) girls selectively attended to happy faces.[4]

Group differences on attentional bias measures do not indicate which of the groups is exhibiting a bias (see Gotlib, McLachlan, & Katz, 1988). Differences between the RSK and CTL participants could be due to one of the groups showing a bias or to both groups showing a bias but to different degrees. To distinguish between these possibilities, we conducted one-sample *t* tests comparing attentional bias scores to zero within each group. These analyses revealed that the CTL participants showed no bias toward sad faces, $t(18) < 1$, but did show a bias toward happy faces, $t(18) = 2.63$, $p < .05$. In contrast, RSK participants showed a significant attentional bias toward sad faces, $t(20) = 3.16$, $p < .01$, but no bias toward happy faces, $t(20) < 1$. In sum, whereas the control girls selectively attended to the happy but not to the sad faces, the girls at risk for depression selectively attended to the sad but not to the happy faces.

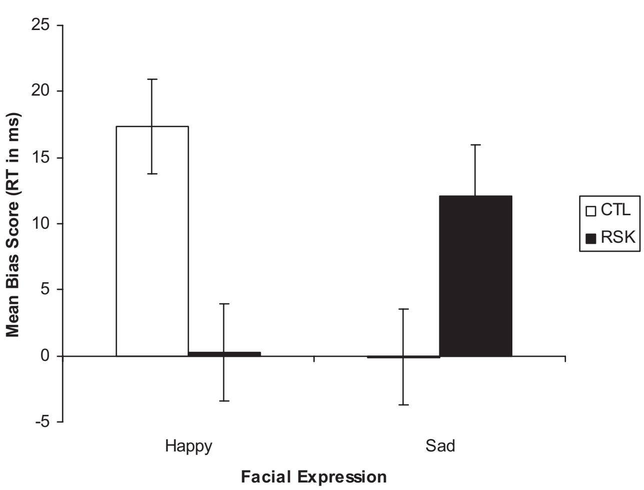

Figure 1. Means and standard errors of the bias scores (in milliseconds) in the dot-probe task in the different groups (RT = reaction time; CTL = control participants; RSK = daughters at risk for major depressive disorder).

Discussion

Despite a growing literature demonstrating that children of depressed mothers are at elevated risk for developing a depressive episode, relatively little is known about the factors and mechanisms that underlie this heightened risk. The present study was designed to examine biases in attention to emotional information in carefully diagnosed never-disordered daughters of mothers with recurrent depression. We compared the functioning of these daughters to that of never-disordered daughters of never-depressed mothers. Consistent with cognitive formulations of the onset of depression, we used a negative mood induction to prime, or activate, negative schemata before assessing biases. We predicted, and found, that whereas the high-risk girls would show an attentional bias toward negative faces but no bias toward positive faces, the control girls would show the opposite pattern of attentional functioning.

This is the first study to assess biases in attentional processing using the dot-probe task following a negative mood induction in high-risk children. This is also one of the first studies to find attentional biases associated with depression or with risk for depression in children. Previous researchers using the dot-probe task have generally not obtained evidence of attentional biases in depressed children (e.g., Neshat-Doost et al., 2000; Taghavi, Neshat-Doost, Moradi, Yule, & Dalgleish, 1999). An important difference between our study and these previous investigations is the use of pictorial stimuli rather than verbal stimuli. It is interesting that in the adult literature, dot-probe studies using extended presentations of facial expressions instead of short presentations of words have yielded a more consistent pattern of findings (Gotlib, Kasch, et al., 2004; Gotlib, Krasnoperova, et al., 2004; for a recent review, see Mogg & Bradley, 2005), a pattern of results that may be due to different stimulus durations capturing different components of attention (e.g., LaBerge, 1995). Bradley, Mogg, and Lee (1997), for example, suggested that depression may be associated not with an initial orienting bias toward negative information but, rather, with difficulty disengaging from this information once it has become the focus of the individual's attention. In addition, given the profound social difficulties experienced by depressed persons (e.g., Feldman & Gotlib, 1993), human faces expressing different emotions are likely to be a particularly salient and powerful type of pictorial stimuli for these individuals. Additional support for the importance of using pictorial stimuli comes from a recent study by Ladouceur et al. (2005), who assessed allocation of attention to task-irrelevant emotional pictures in depressed chil-

[4] See Footnote 3.

dren. Ladouceur et al. reported that whereas depressed children had significantly longer reaction times in the presence of negative distracting pictures, control children had significantly longer reaction times in the presence of positive distracting pictures.

It is interesting that the high-risk girls in our study differed from their low-risk counterparts not only with respect to a negative attentional bias, but also in their attention to positive facial expressions. This positivity bias that was observed in the control children was absent in the high-risk daughters. It is instructive to consider why daughters in the control group might show a positive bias after having been exposed to a negative mood induction, whereas the high-risk children seem to lack this positive bias. Results of previous information-processing studies indicate that nonclinical adult participants focus more on positive emotional information than do clinically depressed individuals (Bradley et al., 1997; Gotlib et al., 1988; Mezulis, Abramson, Hyde, & Hankin, 2005). In addition, as we noted earlier, Ladouceur et al. (2005) found control children to be more distracted by positive pictures than were depressed children. From a theoretical perspective, it is noteworthy that the findings of problematic responses to positive stimuli among high-risk participants are consistent with the tripartite model of depression, which posits that depression is characterized by low levels of positive affect (Clark & Watson, 1991; Watson et al., 1995). Moreover, research with children indicates that the development of attentional control mechanisms, such as the ability to shift attention away from negative stimuli or toward positive stimuli, is related to better regulation of distress and anger (Posner & Rothbart, 2000). Given the importance of being able to shift attention toward positive stimuli when regulating negative emotional states, future researchers of risk factors for depression might profitably examine more explicitly the lack of positivity biases and, more generally, the role of individual differences in the ability to effectively regulate negative mood.

We should point out a number of limitations of the present study. Although we carefully diagnosed mothers and daughters to ensure that there were no current or lifetime diagnoses in the daughters and no current diagnosis of any Axis I disorder, including MDD, in the mothers, the mothers in the high-risk group nevertheless had higher BDI scores than did the never-disordered mothers; moreover, 6 of the 21 mothers with a history of recurrent depression also met diagnostic criteria for another lifetime Axis-I disorder. Thus, we cannot eliminate the possibility that the cognitive biases observed in the daughters are related to the greater incidence of lifetime diagnoses other than depression in their mothers, or to their mothers' elevated levels of current depressive symptoms. The high-risk daughters also had slightly but significantly higher CDI-S scores than did the control daughters. It is important to note, however, not only that the high-risk daughters' CDI-S scores were well below the suggested cutoff scores for clinically significant depression (Kovacs, 1985) but, further, that we used CDI-S scores as a covariate in our analyses. In addition, given the high comorbidity rates of depression and anxiety disorders and symptoms (Kessler, 2002), we administered a self-report measure of anxiety, the MASC. Not only was there not a significant group difference on this measure but, further, using MASC scores as a covariate in our analysis did not affect the results. We are confident in concluding, therefore, that the biases in information processing obtained in our study are not attributable to differences in current symptoms of depression or anxiety. It is possible, of course, that our relatively small sample size precluded the detection of more subtle group differences on these measures or of subtle effects of subthreshold symptoms on dot-probe performance.

Another limitation of the current design involves the nature of the negative mood induction. Guided by the propositions of cognitive models of depression and by previous findings with high-risk children (e.g., Taylor & Ingram, 1999), we made a decision to expose all of our participants to a negative mood manipulation. Consequently, we cannot be certain that our results are dependent on the mood manipulation. Jaenicke et al. (1987), for example, found biased recall in a self-referential encoding task without a mood manipulation, and Garber and Robinson (1997) found negative cognitive styles in self-report measures in high-risk children without a mood induction. In contrast, Taylor and Ingram's (1999) findings of biases were restricted to the group of high-risk children who received a mood induction. Future studies are clearly needed to clarify the role of activating depressive schemas in vulnerability studies with children. Finally, we included only mothers and their daughters in the present study because women have a significantly increased risk of developing a depressive disorder (Hankin & Abramson, 2001). There is certainly no question that fathers can play an important role in the development of psychopathology in their children (Phares & Compas, 1992), and future studies are needed to further clarify this role. Extending this research to the sons of depressed mothers and investigating the role of fathers in the intergenerational transmission of risk for psychopathology are important directions for future studies.

Taken together, the present results provide support for diathesis–stress cognitive models of depression. Although the young girls in the present study had no history and no current diagnosis of any Axis I disorder, they nevertheless exhibited biased attentional processes after being exposed to a negative mood induction. It is interesting that the present results suggest that high-risk children not only orient toward negative stimuli in their environment but that they also lack the positive biases that characterize the control children. Indeed, one might speculate that whereas biased processing of negative information is related to the experience of a depressive episode, biased processing of positive information is an important mechanism of risk for depression. The critical questions that remain are whether these dysfunctional patterns predict the onset of depressive disorders in the high-risk daughters and whether (and how) these dysfunctional patterns are transmitted from mother to daughter. Future studies investigating the predictive value of information-processing biases and mechanisms of the intergenerational transmission of risk for depression are clearly needed and could provide important information for interventions designed to prevent the onset of depression.

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