TEMPERAMENTAL POSITIVE AND NEGATIVE EMOTIONALITY AND CHILDREN’S DEPRESSIVE SYMPTOMS: A LONGITUDINAL PROSPECTIVE STUDY FROM AGE THREE TO AGE TEN

LEA R. DOUGHERTY AND DANIEL N. KLEIN
Stony Brook University

C. EMILY DURBIN
Northwestern University

ELIZABETH P. HAYDEN
University of Western Ontario

THOMAS M. OLINO
Stony Brook University

This study examined associations between temperament at age 3 and maternal reports of youths’ depressive symptoms at ages 7 and 10. Fifty-three preschool aged children were assessed for positive emotionality (PE) and negative emotionality (NE) using maternal reports of temperament and laboratory and naturalistic home observations. Neither PE nor NE at age 3 predicted depressive symptoms.
at age 7 after controlling for children’s anxious/depressive symptoms at age 3. However, both observational and parent-report measures indicated that lower PE at age 3 predicted greater depressive symptoms at age 10 after controlling for NE and anxious/depressive symptoms at age 3. Moreover, mothers’ reports indicated that children with both lower PE and higher NE at age 3 exhibited the greatest increase in depressive symptoms at age 10. Our findings are consistent with models asserting that low PE and/or low PE in conjunction with high NE is a temperamental risk factor for depressive symptoms.

Depressive disorders increase in adolescence to rates comparable to that found in adults (i.e., 14%-20%; Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993), but are relatively uncommon during childhood (i.e., .03%-3.00%; Costello, Foley, & Angold, 2006). Nevertheless, recent investigations have found that depressive symptoms during middle childhood evidence moderate stability and are related to significant concurrent and later impairment (Keenan et al., 2008). Moreover, a recent longitudinal study in preadolescent girls reported that for each increase in depressive symptoms at age 9 years, there was nearly a two-fold increase in the risk of depressive disorders in the following two years (Keenan et al., 2008). This finding supports the clinical significance of investigating depressive symptoms during middle childhood, and that tracing developmental pathways to depressive symptoms can provide clues into the etiology of depression. However, little is known about the early childhood precursors of middle childhood depressive symptoms.

Theorists have long posited that the predisposition for depressive disorders may be rooted in individual differences in temperament (e.g., Akiskal, 1989; Kraepelin, 1921). Temperament refers to characteristic patterns of emotional reactivity that are relatively stable and at least partially influenced by early-developing biological systems (Rothbart & Bates, 2006). Two traits that are central to most models of temperament and personality are positive emotionality (PE) and negative emotionality (NE). PE includes such facets as positive affect, reward seeking and appetitive behavior, sociability, and surgency (Shiner & Caspi, 2003). PE is generally viewed as orthogonal to negative emotionality (NE), which includes such facets as anxiety, sadness, anger, irritability, and negative mood reactivity [although see Russell and Carroll (1999) for an opposing perspective]. Both PE and NE are partially heritable and fairly stable over time in both adults and children (Durbin, Hayden, Klein, & Olino, 2007; Goldsmith, Buss, & Lemery, 1997; Roberts & DelVecchio, 2000).
Several theorists have developed temperament models that link both PE and NE to depression. Most notably, as part of their tripartite model, Clark, Watson, and Mineka (1994) hypothesized that low PE is a specific temperamental predisposition to depression while NE is non-specific to a variety of forms of psychopathology. Other theorists have also posited that facets of PE, such as low hedonic capacity (Hamburg, 1998; Meehl, 1975), appetitive and consumatory pleasure deficits (D.F. Klein, 1987), and behavioral activation or approach system deficits (Davidson, 1998; Depue & Iacono, 1989), are primary etiological factors involved in the development of depression, particularly the early-onset and recurrent forms (Hamburg, 1998; Meehl, 1975).

Studies examining the relations between PE and NE and depression in adult clinical (e.g., Brown, Chorpita, & Barlow, 1998; Watson, Clark, & Carey, 1998) and community (Krueger, Caspi, Moffitt, Silva, & McGee, 1996; Trull & Sher, 1994) samples have supported the hypothesis that temperamental low PE and high NE are associated with depression. In youth, both low PE and high NE have been associated with concurrent depressive symptoms in clinical (Joiner, Catanzaro, & Laurent, 1996; Lonigan, Carey, & Finch, 1994) and community samples (Anthony, Lonigan, Hooe, & Phillips, 2002; Chorpita, 2002; Lonigan, Hooe, David, & Kistner, 1999). In addition, the combination of low PE and high NE was associated with current depressive diagnoses and changes over time in depression in youth psychiatric inpatients (Joiner & Lonigan, 2000).

Although the majority of research linking temperament and depression has consisted of cross-sectional studies, a few longitudinal studies have found that lower levels of PE-related behaviors in childhood predict the development of depressive symptoms (Block, Gjerde, & Block, 1991) and disorders (Caspi, Moffitt, Newman, & Silva, 1996; van Os, Jones, Lewis, Wadsworth, & Murray, 1997). Longitudinal studies have also suggested that NE may be a general risk factor for the development of internalizing disorders (Clark et al., 1994; Lonigan, Phillips, & Hooe, 2003; Rende, 1993).

As only a handful of longitudinal studies have examined the role of early temperamental PE and NE in the development of depressive symptoms or disorders, the current study aims to extend these findings by testing whether lower levels of PE and higher levels of NE in preschool-aged children predict the development of depressive symptoms at ages 7 and 10. In addition, the constructs of PE and NE examined in these prospective studies have been quite
heterogeneous and lacked a multi-method, rigorous assessment in early childhood. Therefore, we examine PE and NE using both maternal reports and standardized laboratory and naturalistic home observations.

We also examine whether the association between temperament and depressive symptoms changes with development. Most attention has focused on the increase in depression during adolescence (Klein, Dougherty, Laptook, & Olino, 2008), as the rates of depressive disorders are relatively rare during childhood (Costello et al., 2006). However, some investigators report an increase in depressive symptoms during the course of middle childhood (Sharp, Goodyer, & Croudace, 2006) with moderate levels of variability (Keenan, Hipwell, Duax, Stouthamer-Loeber, & Loeber, 2004), and findings suggest that these symptoms are not benign (Keenan et al., 2008). It is possible that early temperament may impact the development of depressive symptoms at different points in the developmental course. Therefore, the magnitude of the relations between early temperament and depressive symptoms may be greater at age 10 than at age 7, given the possible developmental changes in the prevalence of depressive symptoms and other maturational processes (e.g., hormones, cognition, socialization) that may be related to increasing risk for depression (Hyde, Mezulis, & Abramson, 2008).

Finally, although the tripartite model (Clark et al., 1994) posits that both low PE and high NE contribute to the development of depression, it does not specify the exact nature of the relations between PE and NE, specifically whether they have additive or interactive effects (Shankman & Klein, 2003). Hence, in addition to examining the main effects of PE and NE at age 3 on later depressive symptoms, we examine whether the combination of both low PE and high NE predict depressive symptoms in middle childhood.

METHOD

PARTICIPANTS

One hundred and six families with 3- to 4-year-old children were recruited for the baseline assessment. Eight participants were excluded; two children had significant medical disabilities, and six families did not complete all assessments. The final baseline sample consisted of 98 children (48 females). Participants were recruited by contacting families living within local zip codes via a commer-
cial mailing list (51%), and through advertisements placed in local newspapers and fliers posted in local preschools (49%). This study was conducted under the oversight of the Committees on Research Involving Human Subjects at Stony Brook University. Written informed consent at each assessment was obtained by parents after the procedures had been fully explained. Given the children’s young age (3 years old) during the baseline assessment, consent was not formally obtained from the child, but children were free to participate or decline to participate at any time.

The children were an average age of 3.6 years (SD = 0.3), mostly white (85%), and of average cognitive ability (M = 104.1, SD = 13.4), as indexed by the Peabody Picture Vocabulary Test (PPVT; Dunn & Dunn, 1997). The mean Hollingshead score of the sample was 35.8 (SD = 9.4), indicating that the families were predominantly working and middle class (Hollingshead, 1975). Both parents were present in most families (97%). The average age of the mothers was 33.8 years (SD = 4.1), and most worked outside the home at least part-time (58%).

Children were reassessed at three later time points when the children were approximately 5, 7, and 10 years old. Data from the age 5 (T2) assessment are not reported in this paper as an extreme group design was used, which included only 30 children (Shankman et al., 2005).

At age 7 (T3), the sample was reassessed to examine the development of depressogenic cognitions (Hayden, Klein, Durbin, & Olino, 2006). Follow-up assessments were obtained for 64 of the 98 children (65%; 32 males, 32 females [see Hayden et al., 2006, for a complete description of this assessment]). At follow-up, the mean child age was 7.0 years (SD = 0.5). Children who were and were not followed up did not differ on family socioeconomic status (SES), CBCL anxious/depressive symptoms, or temperamental PE or NE at age 3. However, age 3 PPVT scores were significantly higher for children who were followed up (M = 106.4, SD = 14.3) compared to those who were not (M = 98.8, SD = 12.0), t(89) = -2.49, p = .01.

The fourth follow-up assessment (T4) was conducted when the children were an average of 10.1 years old (SD = .6). Fifty-three of the 98 children (54%; 24 males, 29 females) from T1 participated at T4 (including 42 who were also assessed at age 7). Of the 45 families who did not participate in the follow-up, nine declined to participate, we were unable to reach 23 families, and 13 mothers who agreed to participate never returned their questionnaire packets.
Families who were and were not followed up did not differ on SES, CBCL anxious/depressive symptoms, or temperament at age 3. Similar to T3, age 3 PPVT scores were significantly higher for children who were followed up \((M = 106.8, SD = 12.0)\) compared to those who were not followed up \((M = 100.2, SD = 14.9)\), \(t (89) = -2.34, p = .02\).

**AGE 3 (T1) MATERNAL REPORT OF TEMPERAMENT**

At T1, mothers completed the Child Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001). The CBQ is a widely used 195-item caregiver report measure of temperament for 3- to 7 year-old children. Mothers rated items on a scale from 1 (extremely untrue) to 7 (extremely true), indicating how closely the statement describes their child’s typical behavior. For this study, we used the following CBQ scales: Smiling/Laughter, Anger/Frustration, Sadness, Fear, Discomfort, and Soothability. Maternal reports of children’s PE at age 3 (i.e., CBQ PE) were based on the Smiling/Laughter scale of the CBQ. To create a composite measure of maternal reports of children’s NE at age 3, we averaged the Anger/Frustration, Sadness, Fear, Discomfort, and Soothability (reverse scored) scales. These scales were chosen to map closely onto the observational assessments of PE and NE used in the present study.

**AGE 3 (T1) LABORATORY ASSESSMENT OF TEMPERAMENT**

Children participated with a female experimenter in 12 standardized tasks selected from the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1995), during which children were videotaped. The tasks were designed to elicit behavioral expressions of a broad range of temperamental traits. Mothers were present in the room for all episodes, with two exceptions noted. Episodes are described in the order in which they were conducted: (1) Risk Room—child played freely with novel and ambiguous stimuli (e.g., cloth tunnel, small staircase, mattress, Halloween mask, balance beam, black cardboard box), followed by the experimenter asking the child to approach each object; (2) Tower of Patience—child and experimenter took turns building a tower of cardboard blocks according to a schedule of increasing delays, which forced the child to wait longer each time
between turns; (3) Arc of Toys—child played freely in a room full of toys and then was asked to clean up; (4) Stranger Approach—a male research assistant entered the room where the child had been left alone and spoke to the child while gradually walking closer; (5) Make That Car Go—experimenter and child raced two remote-controlled racecars; (6) Transparent Box—child was given inoperable keys to open a transparent box that contained an appealing toy, and the experimenter then returned, explaining that she had accidentally given the child the wrong keys; (7) Pop-Up Snakes—experimenter and child played a practical joke on the mother, asking her to open what appeared to be a can of potato chips, but actually contained coiled spring snakes; (8) Snack Delay—child was instructed to wait for the experimenter to ring a bell before eating a snack; (9) Impossibly Perfect Green Circles—experimenter asked the child to draw a circle, during which the experimenter responded by mildly criticizing the child’s work and asking the child to draw another circle; (10) Popping Bubbles—experimenter and child played together with a bubble-shooting toy; (11) Painting a Picture—child played freely with watercolor pencils and crayons; (12) Box Empty—child was left alone with a wrapped empty box to open, under the pretense that an appealing toy was inside.

The coding system has been described in greater detail elsewhere (Durbin, Klein, Hayden, Buckley, & Moerk, 2005; Hayden et al., 2006). Briefly, raters coded videotapes of the Lab-TAB after watching each episode in its entirety, making a single rating for each of the dimensions listed below based upon all relevant behaviors exhibited within that episode. All affects were rated in each episode. For the present study, we used ratings of positive affect, negative affect, sociability, and, as an index of engagement with the environment, interest. Affect ratings were coded on a 5-point scale. Discrete emotions for positive and negative (sadness, anger, and fear) affect were assessed by separately coding facial, vocal, and bodily indicators of the emotion in each episode, which were averaged to produce composite variables for both positive and negative affect. For example, the positive affect scale reflects the frequency and intensity of smiling, positive verbalizations, and joyful bodily movements. Ratings of negative affect (sadness, anger, and fear) were similarly derived using facial, bodily (e.g., slumping posture), and verbal cues (e.g., verbal expressions of anger). Other temperament traits (i.e., sociability, interest/engagement) were coded on a single 4-point rating scale for each episode. Median interrater reliability, assessed by calculating intraclass correlations (ICCs) on 15 of the 98 cases was .82
TEMPERAMENTAL EMOTIONALITY AND DEPRESSIVE SYMPTOMS

(ranging from .66 for fear to .94 for positive affect), and median internal consistency for these scales (coefficient alpha) was .71 (ranging from .56 for interest to .90 for positive affect).

AGE 3 (T1) HOME OBSERVATIONS OF TEMPERAMENT

Each child was observed during two independent 2- to 3-hr home visits (average length of each visit = 2 hr, 32 min) by trained pairs of raters who had no access to laboratory data. Parents were instructed to continue with their usual routine in order to capture a typical day for the child. After each visit, home observation ratings were made using the Child Temperament and Behavior Q-Set (CTBQ-Set; Buckley, Klein, Durbin, Hayden, & Moerk, 2002), which consists of 90 items comprising five scales and 11 subscales. The pairs of raters independently sorted the 90 CTBQ-Set items into nine categories of behavior ranging from 1 = extremely uncharacteristic of the child to 9 = extremely characteristic of the child, producing a fixed distribution of scores for the child. Ratings were aggregated by averaging across all four ratings. For the present study, the following scales were used: low positive affectivity, low sociability, sadness, anger, and emotion regulation deficits (i.e., dysregulated, labile affect). Median interrater reliability, based on all four raters, was .77 (range: .71-.86), and median internal consistency (coefficient alpha) for these scales was .83 (range: .70-.95). Low positive affectivity and low sociability were reverse scored for the present study. The CTBQ-Set scales also displayed moderate test-retest stability between the first and second home visits, which were approximately 5.5 weeks apart, and the construct validity of the CTBQ-Set scales was supported by correlations with maternal ratings of their child’s emotions and behaviors (Buckley et al., 2002).

Data Reduction. We used both structured laboratory tasks and home observations designed to measure individual differences in two temperament superfactors, PE and NE, defined by emotional reactivity and their lower order facets. Following models focusing on the affective components of temperament (Rothbart, Ahadi, & Evans, 2000; Watson & Tellegen, 1985), we grouped lower order facets as follows: PE—positive affect, sociability, and interest/engagement; NE—sadness, anger and fear. These two factors have been consistently supported in the literature with factor analysis of child temperament measures (e.g., Anthony et al., 2002; Durbin et al., 2005; Lonigan et al., 2003; Rothbart et al., 2000).
We chose to combine both laboratory and home observations, as they both have complementary strengths and weaknesses. Laboratory observations provide structured, standardized tasks in controlled situations, allowing for observation of individual differences between children, yet with possibly limited generalizability. On the other hand, home observations are conducted in the child’s natural environment, but where experimental control is lost.

Our lab observation measures exhibited moderate convergence with the home observation measures of the same trait (median $r = .29$), with correlations ranging from .03 (lab and home sadness) to a high of .52 (lab and home positive affect). Overall, PE traits exhibited moderate convergence across lab and home observations ($r = .51$), whereas NE traits exhibited modest convergence ($r = .17$). Nevertheless, in an examination of the temporal stability of observational measures of temperament traits from age 3 to age 7 using this sample, both the age 3 lab and home observations were moderately correlated with lab observations at age 7, and the stability coefficients were larger for the composite NE scale than its separate components (sadness, anger) (Durbin et al., 2007). This is consistent with the basic psychometric principle that aggregating multiple modestly inter-correlated items enhances reliability (Cole, Truglio, & Peeke, 1997). Therefore, we examined composite measures of PE and NE, rather than the discrete emotions that comprise them. Furthermore, it is not surprising that greater discrepancy was observed for negative emotions than positive emotions across methods, given that the expression of negative emotions may be associated with a broader variety of eliciting contexts.

To create aggregate PE and NE across multiple methods and contexts, home observation scores from each of the four raters were $z$-transformed and combined with $z$-transformed ratings of laboratory positive affect, sociability, interest, and negative affect summed across episodes. Specifically, the average was taken of the four standardized home-observed ratings of low positive affectivity and low sociability and the sums of the laboratory ratings of facial, bodily, and verbal positive affect, sociability, and interest. This average yielded a composite measure of home and laboratory PE. Similarly, the four home-observed ratings of sadness, anger, and emotion regulation deficits were combined with laboratory ratings of facial, bodily, and verbal anger, sadness, and fear. This average yielded a composite measure of home and laboratory NE. Internal consisten-
temPeramental emotionality and depressive symptoms for the composite home and laboratory PE and NE scales were .93 and .88, respectively.

AGE 3 (T1) MATERNAL REPORT OF ANXIOUS-DEPRESSIVE SYMPTOMS

Child Behavior Checklist/2-3 (CBCL/2-3). The CBCL/2-3 (Achenbach, Edelbrock, & Howell, 1987) consists of 100 items measuring behavior and adjustment in 2- and 3-year-old children. Mothers rated each item on a scale from 0 (not true) to 2 (very or often true) for their child’s behavior in the past 6 months. In order to control for any depressive symptoms at age 3 (T1), we used the anxious/depressed subscale, as the CBCL/2-3 does not have a validated subscale comprised only of depressive symptoms. Internal consistency of the anxious/depressed subscale in our sample ($\alpha = .74$) was consistent with the literature.

AGE 7 (T3) AND AGE 10 (T4) ASSESSMENTS: MATERNAL REPORTS OF DEPRESSION

Children’s depressive symptoms were measured using maternal reports on the Child Behavior Checklist/4-18 (CBCL; Achenbach, 1991) and the Child Symptom Inventory-4 (CSI-4; Gadow & Sprafkin, 2000).

CBCL. The CBCL consists of 118 items measuring children’s emotional and behavioral problems. Mothers rated each item on a scale from 0 (not true) to 2 (very or often true) for their child’s behavior in the past 6 months. As none of the CBCL scales assess only depressive symptoms, we used Lengua, Sadowski, Friedrich, and Fisher’s (2001) rationally and empirically derived CBCL depression scale, which has been validated in multiple samples and has been shown to have adequate sensitivity, specificity, and discriminant validity. This scale was designed to map more directly onto the diagnostic

---

1. For exploratory purposes, we constructed a depression scale from the CBCL/2-3 that removed any items assessing anxious symptoms. This set of items was strongly correlated ($r = .67, p < .001$) with the CBCL/2-3 anxious/depressed scale, and the magnitude and directionality of all correlations with the study variables presented in Table 2 are similar. Therefore, we present the data using the original CBCL/2-3 anxious/depressed scale, as it is widely used in the literature.
categories currently in use and to separate anxiety and depressive symptoms that have been shown to be distinct. The depression scale consists of 12 items from the original CBCL assessing depressed mood (3 items), sleep changes (3 items), decreased energy (2 items), feelings of worthlessness (2 items), and thoughts of death/suicide (2 items). Internal consistency of the maternal reports was consistent with the literature (T3 $\alpha = .69$ and T4 $\alpha = .81$). The means and standard deviations of the CBCL depression scale at T3 ($M = 1.09$, $SD = 1.76$, Range = 0 to 9) and T4 ($M = 1.11$, $SD = 2.20$, Range = 0 to 12) are consistent with nonclinic samples of similarly aged children (Lengua et al., 2001).

**CSI-4.** The CSI-4 is a behavior rating scale whose items correspond to the symptoms of disorders defined by the *Diagnostic Statistical Manual of Mental Disorders, 4th edition* (American Psychiatric Association, 1994). The CSI-4 has been validated for children 5 to 13 years of age (Grayson & Carlson, 1991). The major depressive disorder (MDD) scale consists of 10 items, each scored as 0 (never), 1 (sometimes), 2 (often), or 3 (very often). MDD symptom severity scores are derived from the sum of these scores. As expected, CSI symptom severity scores for the MDD scale were low at T3 (age 7: $M = .51$, $SD = 1.10$, Range = 0 to 5) and T4 (age 10: $M = 1.13$, $SD = 1.56$, Range = 0 to 7). One child at T3 and two children at T4 fell within the moderate severity range on the MDD scale. Internal consistency of the MDD scale in our sample was consistent with the literature (T3 $\alpha = .70$ and T4 $\alpha = .62$) (Sprafkin, Gadow, Salisbury, Schneider, & Loney, 2002).

As Lengua et al.’s (2001) CBCL depression scale and the CSI MDD scale were correlated for mothers at T3 and T4 (both $r’s = .59$, $p < .001$), we created composite scores of youths’ depressive symptoms by averaging the standardized z-scores of the two scales. Both skew (2.31 and 1.97) and kurtosis (5.87 and 3.94) were out of the acceptable range for age 7 and age 10 composite youths’ depressive symptoms, respectively. Therefore, we performed a square root transformation to the data, which yielded normally distributed variables with respect to skew (.96 and .47) and kurtosis (.45 and -.01) for depressive symptoms at age 7 and 10, respectively. These transformed composite scores were used as the assessment of maternal reports of youths’ depressive symptoms at ages 7 and 10. All other study variables were normally distributed and did not require transformation.
RESULTS

For descriptive purposes, we first report the zero-order correlations between variables. Then we report a series of multiple regression analyses examining whether PE and NE at age 3 predict depressive symptoms at ages 7 and 10 after controlling for child age, gender, and anxious/depressive symptoms at age 3. Controlling for anxious/depressive symptoms at age 3 provides a conservative test, as it attributes all variance shared between age 3 temperament and later symptoms to earlier symptoms. However, results were generally similar when age 3 anxious/depressive symptoms were not included in the model. Lastly, it is important to note that, due to sample attrition, the analyses reported below have varying sample sizes depending on which follow-up assessments were included in the analysis (included samples: T1 and T3, N = 60; T1 and T4, N = 53; T1, T3, and T4, N = 42).

ZERO-ORDER CORRELATIONS BETWEEN VARIABLES

Correlations between all major variables can be seen in Table 1. For all analyses, the child temperament and depression variables were treated as continuous. Age was significantly correlated with observed PE, such that older preschoolers exhibited higher levels of PE than younger preschoolers. In addition, mothers reported that girls exhibited significantly higher levels of PE than boys.

Concurrent correlations at age 3 demonstrated that observed NE and maternal reports of NE were significantly correlated, whereas observed PE and maternal reports of PE were not significantly correlated. Maternal reports on the CBCL/2-3 anxious/depressed scale were significantly and positively related to concurrent maternal reports of NE and were significantly and negatively related to maternal reports of PE. However, maternal reports of anxious/depressive symptoms at age 3 were not significantly correlated with

---

2. When analyses were limited to the 42 participants who completed all three assessments, the findings were similar to those reported in the text and tables. For these 42 participants, the observed Pearson product-moment correlation coefficients were: observed PE with age 7 depressive symptoms (-.08) and with age 10 depressive symptoms (-.34); observed NE with age 7 depressive symptoms (-.22) and with age 10 depressive symptoms (.03); maternal-reported PE with age 7 depressive symptoms (-.02) and with age 10 depressive symptoms (-.40); maternal-reported NE with age 7 depressive symptoms (.30) and with age 10 depressive symptoms (.28).
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Youth Depressive Symptoms (age 7)</td>
<td>—</td>
<td>.54***</td>
<td>.31*</td>
<td>-.02</td>
<td>.24†</td>
<td>-.13</td>
<td>.30*</td>
<td>-.13</td>
<td>.17</td>
<td>.04</td>
</tr>
<tr>
<td>2. Youth Depressive Symptoms (age 10)</td>
<td>—</td>
<td>.50***</td>
<td>-.28*</td>
<td>.10</td>
<td>-.39**</td>
<td>.33*</td>
<td>-.19</td>
<td>.05</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td>3. CBCL Anxious/Depressed (age 3)</td>
<td>—</td>
<td>-.09</td>
<td>.08</td>
<td>-.27**</td>
<td>.49***</td>
<td>-.13</td>
<td>-.07</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Observed PE (age 3)</td>
<td>—</td>
<td>-.17†</td>
<td>.11</td>
<td>-.11</td>
<td>.25*</td>
<td>-.04</td>
<td>.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Observed NE (age 3)</td>
<td>—</td>
<td>-.06</td>
<td>—</td>
<td>.24*</td>
<td>-.16</td>
<td>.11</td>
<td>-.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. CBQ PE (age 3)</td>
<td>—</td>
<td>-.11</td>
<td>.05</td>
<td>-.03</td>
<td>.21*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. CBQ NE (age 3)</td>
<td>—</td>
<td>—</td>
<td>.13</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Age</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. SES (age 3)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Gender</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( M )</td>
<td>.76</td>
<td>1.18</td>
<td>.34</td>
<td>.02</td>
<td>.01</td>
<td>5.87</td>
<td>2.38</td>
<td>10.07</td>
<td>34.8</td>
<td>—</td>
</tr>
<tr>
<td>( SD )</td>
<td>1.27</td>
<td>1.41</td>
<td>.26</td>
<td>.75</td>
<td>.35</td>
<td>.66</td>
<td>.57</td>
<td>.56</td>
<td>9.8</td>
<td>—</td>
</tr>
</tbody>
</table>

Note. Youth depressive symptoms = combined maternal reports on the Child Behavior Checklist depression scale and Child Symptom Inventory MDD scale; CBCL = Child Behavior Checklist/2-3; PE = positive emotionality; NE = negative emotionality; CBQ = Child Behavior Questionnaire; SES = socioeconomic status; Gender: male = 1, female = 2; *Combined home and laboratory observations of temperament. \( \text{tp} < .10 \), \( \text{tp} < .05 \), \( \text{tp} < .01 \), \( \text{tp} < .001 \).
observed NE or PE at age 3. Maternal reports of anxious/depressive symptoms at age 3 were significantly correlated with age 7 and age 10 maternal reports of youths’ depressive symptoms, and the magnitude of the associations increased from age 7 to age 10. Maternal reports of youths’ depressive symptoms at age 7 were also significantly and moderately correlated with maternal reports of youths’ depressive symptoms at age 10. These findings demonstrate a moderate level of rank-order stability in maternal reports of youths’ depressive symptoms from age 3 to age 10, suggesting that the stability observed in middle childhood (Keenan et al., 2008) is also evident at younger ages.

Observed PE and maternal reports of PE at age 3 were significantly and negatively correlated with youths’ depressive symptoms at age 10; however, PE was not associated with youths’ depressive symptoms at age 7. Maternal reports of NE at age 3 were significantly and positively associated with youths’ depressive symptoms at age 7 and age 10, and observed NE was marginally significantly correlated with youths’ depressive symptoms at age 7.3

MULTIPLE REGRESSION ANALYSES

Predicting Age 7 Depressive Symptoms. To determine whether age 3 temperament continued to predict maternal reports of youths’ depressive symptoms at age 7 after controlling for children’s anxious/depressive symptoms at age 3, we conducted a hierarchical multiple regression analysis (see Table 2). After controlling for age, gender, and children’s anxious/depressive symptoms at age 3, observed PE and observed NE at age 3 did not significantly predict youths’ depressive symptoms at age 7. Furthermore, this finding was replicated using maternal CBQ reports of PE and NE at age 3. Thus, neither PE nor NE at age 3 significantly predicted youths’ depressive symptoms at age 7 after controlling for age, gender, and anxious/depressive symptoms at age 3.

3. It is plausible that the internalizing/withdrawal emotions of sadness and fear are more closely associated with subsequent depressive symptoms than the more externalizing/approach emotion of anger. Therefore, we conducted supplementary analyses parsing NE into withdrawal (sadness and fear) and approach (anger) emotions and examining the effects separately for the observational and maternal-reported temperament data. No consistent patterns emerged and the correlations were largely similar to those reported for the composite measures of observed NE and maternal-reported NE reported in Table 2. Data are available by request from the first author.
### TABLE 2. Hierarchical Multiple Regressions for Predictors of Maternal Reports of Child Depressive Symptoms at Age 7 and Age 10

<table>
<thead>
<tr>
<th>Variable</th>
<th>Age 7</th>
<th>Age 10</th>
<th>Variable</th>
<th>Age 7</th>
<th>Age 10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\Delta^2$</td>
<td>$r^2$</td>
<td></td>
<td>$\Delta^2$</td>
<td>$r^2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 1:</strong></td>
<td></td>
<td></td>
<td><strong>Step 1:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.11</td>
<td>0.25</td>
<td>Age</td>
<td>-0.08</td>
<td>-0.09</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.09</td>
<td>-0.09</td>
<td>Gender</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>CBCL anxious/depressed</td>
<td>0.30*</td>
<td>0.46**</td>
<td>CBCL anxious/depressed</td>
<td>0.29*</td>
<td>0.46**</td>
</tr>
<tr>
<td>(age 3)</td>
<td></td>
<td></td>
<td>(age 3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2:</strong></td>
<td></td>
<td></td>
<td><strong>Step 2:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed PE a (age 3)</td>
<td>0.11</td>
<td>0.07</td>
<td>Observed PE a (age 3)</td>
<td>-0.01</td>
<td>-0.31*</td>
</tr>
<tr>
<td>Observed NE a (age 3)</td>
<td>0.21</td>
<td>-0.03</td>
<td>Observed NE a (age 3)</td>
<td>0.18</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Note. Depressive symptoms = combined maternal reports on the Child Behavior Checklist depression scale and Child Symptom Inventory MDD scale; CBCL = Child Behavior Checklist/2-3; PE = positive emotionality; NE = negative emotionality; CBQ = Child Behavior Questionnaire; a = Combined home and laboratory observations of temperament; N = 60 at age 7; N = 53 at age 10; *$p < .05$, **$p < .01$. 
Predicting Age 10 Depressive Symptoms. To determine whether low PE and high NE at age 3 predicted maternal reports of youths’ depressive symptoms at age 10 after controlling for age 3 maternal reports of children’s anxious/depressive symptoms, we conducted a similar set of hierarchical multiple regression analyses (see Table 2). After controlling for age, gender, and children’s anxious/depressive symptoms at age 3, observed PE at age 3, but not observed NE at age 3, significantly predicted youths’ depressive symptoms at age 10. These analyses were replicated using maternal CBQ reports of PE and NE at age 3. Maternal CBQ reports of PE at age 3, but not maternal CBQ reports of NE, significantly predicted youths’ depressive symptoms at age 10 after controlling for children’s anxious/depressive symptoms at age 3.

Our finding that PE at age 3 predicted youths’ depressive symptoms at age 10 but not at age 7 suggests that the relationship between early temperament and later depressive symptoms may only begin to emerge as depressive symptoms increase from early childhood to middle childhood. Indeed, when the analyses were limited to the 42 children who were assessed at ages 7 and 10, a paired-samples t-test indicated that depressive symptoms demonstrated a significant and moderate-size increase from age 7 to age 10, $t(41) = 2.50, p = .01$ (Cohen’s $d = .59$).

In order to explore this further, we examined whether PE and NE at age 3 continued to predict depressive symptoms at age 10 after controlling for youths’ depressive symptoms at age 7. These analyses were limited to the 42 participants who provided data at ages 3, 7, and 10. Age, gender, CBCL anxious/depressed symptoms at age 3, and youths’ depressive symptoms at age 7 were entered in Step 1, and observed PE and observed NE were entered in Step 2. Observed PE ($r = -.34, p < .05$) continued to uniquely predict age 10 depressive symptoms over and above depressive symptoms at ages 3 and 7, as well as observed NE at age 3. Observed NE was not a significant predictor.

This analysis controlling for anxious/depressive symptoms at age 3 and youths’ depressive symptoms at age 7 was repeated using maternal CBQ reports of PE and NE at age 3. There was a trend for maternal CBQ reports of PE at age 3 ($r = -.30, p = .07$) to predict youths’ depressive symptoms at age 10 over and above depressive symptoms at ages 3 and 7 and maternal reports of NE at age 3. Maternal reports of NE at age 3 did not predict youths’ depressive symptoms at age 10.
symptoms at age 10 after controlling for depressive symptoms at age 7.

Does Low PE Interact with High NE to Predict Youths’ Depressive Symptoms? First, we used hierarchical multiple regression to examine whether PE and NE interacted in predicting youths’ depressive symptoms at age 7. Each predictor variable was initially centered to minimize multicollinearity, and interaction terms were formed as the product of the two centered predictors (Aiken & West, 1991). Children’s anxious/depressive symptoms at age 3 were entered in Step 1, main effects (PE and NE) were entered in Step 2, and the cross-product term for PE and NE was entered in Step 3. The interactions between observed PE and NE ($pr = -.09, n.s.$) and maternal CBQ reports of PE and NE ($pr = .01, n.s.$) were not significant in their respective models.

Next, similar to the age 7 analyses, we used hierarchical multiple regression to examine whether PE and NE interacted in predicting youths’ depressive symptoms at age 10. The interaction between maternal CBQ reports of PE and NE was significant ($pr = -.28, p < .05$). The significant interaction was decomposed using the procedure outlined by Aiken and West (1991). The effect of CBQ NE at age 3 on depressive symptoms at age 10 was estimated at 1 SD below the mean (low) and 1 SD above the mean (high) on CBQ PE. As shown in Figure 1, CBQ PE interacted with CBQ NE to predict depressive symptoms at age 10 such that high NE was related to greater depressive symptoms among children who were low in PE ($b = .77$, $SE = .34$, $ß = .43$, $p < .05$). In contrast, among high PE children, high NE was not correlated with depressive symptoms at age 10 ($b = -.02$, $SE = .27$, $ß = -.01$, n.s.). Thus, the combination of low PE and high NE at age 3 predicted the greatest increase in depressive symptoms at age 10. The interaction between observed PE and NE at age 3 on depressive symptoms at age 10 was not significant ($pr = -.16, n.s.$).

**DISCUSSION**

We found that lower PE at age 3 predicted youths’ depressive symptoms at age 10 using both observational and parent-reports of temperament (although the latter was qualified by a significant interaction with NE, as discussed further below). These findings held after controlling for child age, sex, and NE and anxious/de-
temPeramental emotionality and depressive symptoms at age 3. Moreover, when depressive symptoms at age 7 were also controlled, the effect for observed PE remained significant, while the effect for parent-reported PE was reduced to a trend. These findings are particularly noteworthy, as depressive symptoms were moderately stable over time, reducing the amount of variance left over for other variables, such as PE, to predict.

Interestingly, PE at age 3 did not predict depressive symptoms at age 7. The finding that the PE-depression link did not emerge until age 10 may be related to the increase in depressive symptoms from age 7 to age 10 that we observed. Some research reports developmental differences in depressive symptoms (e.g., certain symptoms become more common as children mature; Weiss & Garber, 2003). It is possible that the relation between low PE and depressive symptoms might be stronger as certain symptoms become more prevalent. This developmental change in the association between low PE and depressive symptoms appears consistent with evidence that the genetic heritability of depression also changes across the course

FIGURE 1. Interaction between PE and NE at age 3 predicting youths’ depressive symptoms at age 10. Regression lines are plotted for individuals scoring 1 standard deviation above and 1 standard deviation below the sample mean on maternal CBQ reports of children’s PE at age 3. Simple slopes are unstandardized regression coefficients.
of development (Lau & Eley, 2008). In addition, other developmental processes that are occurring during middle childhood may be involved in the pathway from early temperament to later depression. Children are undergoing many cognitive, biological, and social changes during this period of development. Therefore, it is possible that the effects of low PE on later depression may be mediated or moderated by more proximal risk factors, such as depressotypic cognitive biases, stressful life events, or maladaptive interpersonal or coping, self-regulatory behaviors (Compas, Connor-Smith, & Jaser, 2004; Hayden et al., 2006; Klein et al., 2008). For instance, among children with low levels of PE, parental rejection was more strongly related to increasing depressive symptoms (Lengua, Wolchik, Sandler, & West, 2000). Likewise, among girls with more reactive temperaments, peer rejection predicted increases in depressed mood (Brendgen, Wanner, Morin, & Vitaro, 2005).

We did not find as much support for the direct effect of NE on subsequent depressive symptoms after controlling for anxious/depressive symptoms at age 3. It is possible that the lack of direct effects may be due to the limited power observed in the study. For instance, even though age 3 observed and maternal-reported NE had small effects on youths’ depressive symptoms at age 7 (as seen in Table 2), similar sized effects may have been significant in a larger sample (i.e., these effects would have reached significance with power of .80 if the sample included approximately 185 children). Additionally, it is possible that NE exerts indirect effects on depression, possibly by moderating the association between stress and depression (Hyde et al., 2008) or by moderating the association between other temperamental traits, such as effortful control, and depression (Muris, 2006; Oldenhinkel, Hartman, Ferdinand, Verhulst, & Ormel, 2007; Verstraeten, Vasey, Raes, & Bijttebier, 2009). More longitudinal research examining the direct and indirect pathways from early temperament to depression is needed.

We found that for maternal reports, PE and NE interacted in predicting depressive symptoms at age 10. Specifically, the combination of parent-reported low PE and high NE at age 3 was more strongly related to increasing depressive symptoms at age 10 than either temperament dimension alone. These findings must be re-

4. Youths’ depressotypic cognitive styles were assessed at age 7 in this longitudinal study; however, we do not report mediation/moderation analyses using this data given the substantial decrease in sample size and power when the age 7 cognitive variables are included.
Temperamental emotionality and depressive symptoms are regarded cautiously because they were not evident in the analyses using observational measures of temperament. However, they are consistent with a study by Joiner and Lonigan (2000), who found that the interaction between self-reported low PE and high NE predicted later symptoms of depression in child and adolescent psychiatric inpatients. Furthermore, our findings extend the Joiner and Lonigan study to younger children from a community sample using observational and parent-report measures.

It is of interest to consider why the combination of low PE and high NE may be particularly likely to lead to depression. One possibility is that individuals with low PE experience more persistent negative affect in response to stress and adversity, which could increase the risk of developing depressive symptoms over time. Research has shown that positive emotions help individuals “bounce back” from negative emotional experiences, as well as better cope with adversity, by enhancing emotion regulatory and problem-solving abilities (Fredrickson & Branigan, 2005; Tugade & Fredrickson, 2004).

As noted above, our findings differed somewhat for the observational and parent-report measures of temperament. This is not surprising given that the correlations between these two approaches were low, as is typical of the literature (e.g., Kochanska, Coy, Tjebkes, & Husarek, 1998; Seifer, Schiller, Sameroff, Resnick, & Riordan, 1996). Moreover, the parent report temperament and youth depression measures used the same informant and method, whereas shared method factors did not play a role in the analyses using observational measures of temperament. In light of these factors, it is noteworthy that low PE at age 3 predicted depressive symptoms at age 10 using both parent-report and observational measures of temperament, despite the low convergence of these two measures of the same trait.

The observed longitudinal association between low PE at age 3 and depressive symptoms at age 10 could reflect the continuity of temperament from age 3 to age 10 (Durbin et al., 2007; Komsi et al., 2006), as low PE overlaps with the depressive symptom anhedonia. If this is the case, it suggests that what we currently construe as early childhood temperament may actually reflect early-emerging symptoms of depression. Indeed, Angold and Costello (2008) recently argued that research on early temperament may provide the foundation for the assessment and classification of psychopathology in early childhood. We are not able to test this hypothesis, as similar follow-up assessments of temperament were not employed.
at each assessment. Nevertheless, this possibility raises important conceptual issues in understanding the relation between temperament/personality and psychopathology, including the difficulty of determining the extent to which the two constructs overlap and/or are distinct, and how best to measure them (Frick, 2004). Nevertheless, there is some evidence to suggest that when item overlap is removed, temperament continues to predict measures of psychopathology (Lemery, Essex, & Smider, 2002; Lengua, West, & Sandler, 1998). To explore this further with our data, we removed all items related to anhedonia from the CBCL and CSI depression scales. The correlations between observational and maternal-reported PE and the modified measures of depressive symptoms at age 10 were -.25 and -.31, respectively, which is only slightly lower than the corresponding correlations in Table 1. Therefore, the association between low PE and depressive symptoms does not appear to be driven only by its relation to anhedonia. Along with our finding that low PE did not predict depressive symptoms at age 7, these correlations argue against the claim that our findings merely reflect the continuity of temperament.

This study had several significant strengths. We examined the prospective, longitudinal association between early temperamental emotionality and depressive symptoms in a community sample of children using multiple methods of assessing temperament. However, the study also had several limitations. First, the sample was small and there was a significant amount of attrition, which may have biased the findings. Second, we used a non-patient sample that was predominantly white and working/middle-class. Hence, it is unclear whether the findings apply to clinical samples or more diverse populations.

Third, the assessment of children’s depressive symptoms was limited to maternal report. Nevertheless, there is evidence that parent reports are particularly important for pre-adolescent children due to developmental limitations in cognitive processes and language abilities (Edelbrock, Costello, Dulcan, Kalas, & Conover, 1985). Fourth, we assessed depressive symptoms rather than diagnoses. We cannot assume that our findings can be generalized to depressive disorders. However, depressive symptoms during middle childhood appear to have clinical significance in their own right, as they have been shown to be related to concurrent impairment and predictive of subsequent depressive disorders (Keenan et al., 2008). Lastly, we did not examine the specificity of the associations be-
tween temperament and psychopathology by assessing other forms of psychopathology, such as anxiety and externalizing symptoms.

Implications for Future Research and Clinical Practice. More research is needed to examine temperamental models of psychopathology, particularly incorporating a multi-method assessment of temperament and the use of longitudinal designs to trace the developmental pathway from early temperament to depression. Some possible mediators and moderators that may be involved include parental history of mood disorders (Durbin et al., 2005), EEG asymmetries (Shankman et al., 2005), depressotypic cognitive styles (Hayden et al., 2006), parenting and family/peer contexts (Lengua et al., 2000), stress reactivity (Tugade & Fredrickson, 2004), and other temperamental traits such as effortful control (Verstraeten et al., 2009). It is also important to explore how developmental changes, including changes in cognitive, biological, and social maturational processes, influence the longitudinal relation between early temperament and later depression. It will be of particular interest to examine whether temperament predicts the sharp increase in depression in early adolescence, and to explore its role in the gender differences that emerge during that period. Finally, our findings raise the possibility that temperament may provide a useful means of targeting at-risk children as early as the preschool years for primary prevention programs designed to stave off the later development of depression.

REFERENCES


