Cognitive and temperamental vulnerability to depression: Longitudinal associations with regional cortical activity

Elizabeth P. Hayden, Stewart A. Shankman, Thomas M. Olino, C. Emily Durbin, Craig E. Tenke, Gerard E. Bruder & Daniel N. Klein

Available online: 15 Oct 2008

To cite this article: Elizabeth P. Hayden, Stewart A. Shankman, Thomas M. Olino, C. Emily Durbin, Craig E. Tenke, Gerard E. Bruder & Daniel N. Klein (2008): Cognitive and temperamental vulnerability to depression: Longitudinal associations with regional cortical activity, Cognition & Emotion, 22:7, 1415-1428

To link to this article: http://dx.doi.org/10.1080/02699930701801367

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.tandfonline.com/page/terms-and-conditions

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan,
sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.
Cognitive and temperamental vulnerability to depression: Longitudinal associations with regional cortical activity

Elizabeth P. Hayden
University of Western Ontario, London, Ontario, Canada

Stewart A. Shankman
University of Illinois-Chicago, Chicago, IL, USA

Thomas M. Olino
Stony Brook University, Stony Brook, NY, USA

C. Emily Durbin
Northwestern University, Evanston, IL, USA

Craig E. Tenke and Gerard E. Bruder
New York State Psychiatric Institute, New York, NY, USA

Daniel N. Klein
Stony Brook University, Stony Brook, NY, USA

Posterior cortical activity may be related to individual differences in temperamental emotionality, especially traits implicated in depression vulnerability. We previously reported that electroencephalographic (EEG) indices of cortical activity in posterior regions were associated with temperamental positive emotionality (PE) in early childhood. This project examined whether EEG indices of regional cortical activity, assessed at age 5–6, were associated with child temperament and cognitive vulnerability to depression, assessed at age 7. Asymmetry in posterior cortical activity measured at age 5–6 was associated with PE at follow-up at age 7, and with greater helplessness during a standardised laboratory task simulating a mild interpersonal rejection. Findings provide further support for the notion that low PE and depression are associated with similar patterns of cortical activity. Furthermore, these patterns of activity may have observable behavioural and cognitive correlates that are meaningfully linked to the phenomenology of depression.
In recent decades, an extensive literature has emerged using electroencephalographic (EEG) indices of cortical activity to examine regional brain activity in normal and abnormal emotional experience. In particular, a large body of research has examined the association between depression and asymmetrical patterns of brain activity in anterior regions (Thibodeau, Jorgensen, & Kim, 2006). In adult samples, evidence indicates that lower left anterior cortical activation, relative to right, is associated with current depression (Gotlib, Ranganath, & Rosenfeld, 1998; Henriques & Davidson, 1991) and past history of depression (Gotlib et al., 1998; Henriques & Davidson, 1990), although inconsistent results have also been reported (e.g., Reid, Duke, & Allen, 1998).

While anterior regions have been the focus of most recent research, other brain regions have also been implicated in depression and depression vulnerability. There is substantial evidence for right hemispheric regulation of emotional processing (Borod, 1992). This region may also play a special role in emotional experience in depression. Several authors have reported an association between cortical asymmetry in posterior regions and depression in adolescence and adulthood, with lower activity in right parietal sites (Bruder, Fong, Tenke, & Leite, 1997; Davidson, Chapman, & Chapman, 1987; Kentgen et al., 2000; Reid et al., 1998), although at least one study did not find this asymmetry (Henriques & Davidson, 1991). A similar posterior cortical asymmetry has been found in the offspring of depressed parents (Bruder et al., 2005). Our group (Shankman et al., 2005) recently reported that posterior cortical asymmetry was associated with lower temperamental positive emotionality (PE) in children, a trait reflecting the propensity to experience positive mood states, to be highly sociable, and to be engaged with the environment. Deficits in PE have been invoked as a vulnerability factor for depression in both theoretical writings and empirical work (e.g., Brown, Chorpita, & Barlow, 1998; Clark & Watson, 1991; Meehl, 1975). As lower PE in childhood is associated with established risk markers for depression (Durbin, Klein, Hayden, Buckley, & Moerk, 2005), our findings are consistent with the notion that asymmetry in cortical activity in posterior regions may index an early emerging vulnerability to depression that has observable emotional and behavioural correlates.

This idea is supported in the work of Heller and colleagues (Heller, Nitschke, & Miller, 1998), who have argued that decreased activity in right posterior regions, relative to left, is associated with impaired processing of emotionally significant stimuli. These authors view this cortical area as playing a critical role in the activating and arousing aspects of affect (Heller, 1993). Decreased activity in right, relative to left, posterior regions may be associated with difficulty in appraising the affective significance of environmental stimuli; previous work from our group suggests that activity in these regions may be most important in processing positive/rewarding stimuli, as
opposed to negative stimuli (Shankman et al., 2005). Similarly, Kayser, Bruder, Tenke, Stewart, and Quitkin (2000) reported findings suggesting that right posterior regions are necessary in perceiving and evaluating emotional stimuli and that activity in these regions appears to be disrupted in depression.

Heller and colleagues proposed that right posterior activity has implications not only for emotional experience, but for cognitive processing as well. Much less is known about the associations between right posterior cortical activity and cognition in depression. Additionally, while cognitive theories of depression are highly influential in the field, and while evidence indicates that negative cognitive styles predict the development of depression (e.g., Alloy et al., 2006), little is known about the cortical instantiations of increased cognitive vulnerability to depression.

With these previous findings in mind, we examined the longitudinal relationship between EEG measures of regional cortical activity, measured when children were aged 5–6, and emotional temperament and depressotypic cognitive styles, measured when children were 7. We expected that EEG asymmetries similar to those reported for depressed individuals (namely, a posterior asymmetry reflecting greater left relative to right cortical activity) would be associated with lower levels of PE at follow-up. Also based on previous findings from our group, we predicted that this asymmetry would show a specific association with PE and not negative emotionality (NE). NE, the trait-like predisposition to experience an array of negative moods, including anger, sadness, and fear, has also been linked to depression (Clark & Watson, 1991); however, we did not previously find associations between this trait and posterior cortical asymmetry, suggesting some degree of specificity of cortical activity in these regions to positive emotional experience and/or expression.

We also predicted that posterior cortical asymmetry would be associated with increased helplessness and other information processing styles implicated in depression. We assessed children at age 7 follow-up on laboratory measures of depressotypic cognitions (Hayden, Klein, Durbin, & Olino, 2006). Children were assessed for helplessness in an interpersonal evaluative context using a standardised task developed for use with children. We also assessed negative and positive schematic processing following a negative mood induction, and collected self-reports of depressive symptoms.

METHOD

Participants

A subset of 100 children from a larger study of temperamental precursors of depression participated in the present study. The original sample of 3-year-old children and their families from the community was recruited via
newspaper advertisements, flyers in local preschools, and commercial mailing lists. These children were assessed at baseline for temperament using tasks drawn from the Laboratory Temperament Assessment Battery (Lab-TAB; Goldsmith, Reilly, Lemery, Longley, & Prescott, 1995), a standardised battery of laboratory tasks designed to elicit temperamental emotionality. Tasks were videotaped for future coding by trained graduate and undergraduate coders who rated children on multiple dimensions of temperament and behaviour, including PE and NE. Details on this baseline assessment and coding procedures are available in other publications from our group (Durbin et al., 2005; Hayden, Klein, Durbin, & Olino, 2006; Shankman et al., 2005). Children whose scores fell in the upper and lower 25% on measures of PE at age 3 were invited to return for follow-up assessments, including an EEG session, when they were between the ages 5 and 6. Forty-one (78.8%) of the 52 eligible children (mean age = 6.16, SD = 0.47) participated in this follow-up. The participants targeted for follow-up did not differ from those who were not targeted on age 3 NE or family socioeconomic status. As is standard in research on EEG and emotionality (Gotlib et al., 1998; Henriques & Davidson, 1990, 1991; Reid et al., 1998), only the 73.2% (N = 30) right-handed children (determined by observed performance on lateral preference tasks; see Shankman et al., 2005) were included in the EEG study session. One child was excluded due to an inadequate number of artefact-free epochs, resulting in a final sample of 29 children.

**Electroencephalography**

Greater detail on our EEG data-collection procedures has been provided elsewhere (Shankman et al., 2005). Briefly, children were seated comfortably in a dimly lit, sound-attenuated booth, and a “space” motif was used to increase compliance with procedures; for example, the electrode cap was referred to as a space helmet and the booth was described as a spaceship. Children were given prizes for each successful “space mission” (each recorded block, described below).

Resting EEGs were recorded over six 60-second blocks of eyes-open (O) and eyes-closed (C) conditions, presented in one of two counter-balanced orders (OCCOOC or COOCOO). Scalp EEG was recorded from six lateral pairs of electrodes (F7/F8, F3/F4, T7/T8, C3/C4, P7/P8, and P3/P4) and from one midline electrode (Cz) using an electrode cap (Electro Cap International, Inc., Eaton, Ohio, USA) with a left ear reference. Additional electrodes at supra- and infraorbital sites surrounding the right eye were used to monitor eyeblinks and vertical eye movement and electrodes at right and left outer canthi monitored horizontal eye movements. Data were collected from the right ear to rereference the scalp data off-line to a linked-
ear reference. Because reference scheme may influence measures of hemispheric asymmetry, epoched data were also rereferenced to Cz. The linked-ear rereferenced data were used in the present paper, although the results from the two references were highly consistent. All electrodes’ impedances were below 5 kΩ and homologous electrodes were within 1.5 kΩ of each other. The EEG was recorded with a Grass Neurodata acquisition system at a gain of 10 K (5 K for eye channels) with a bandpass of 1–30 Hz. A PC-based EEG acquisition system (Neuroscan 4.1) acquired and digitised the data continuously at 1000 Hz over each 60-second block. Data were segmented into 2.048 s epochs every 1.024 s (50% overlap; yielding approximately 180 epochs/condition) and then examined for evidence of amplifier saturation. After referencing to a linked ear reference off line, data were baseline corrected and epochs contaminated by blinks and other artefacts were excluded. The EEG was then tapered over the entire epoch by a Hanning window to suppress spectral sidelobes. Artefact-free data, which were attenuated at the beginning and end of an epoch, were recovered in adjacent (overlapping) epochs.

Alpha power (7–12 Hz) was computed and log transformed to address positive skew. This range was empirically validated by assuring that the alpha peak was approximately centred in this band for every subject. To represent asymmetries in regional cortical activity (following Pivik et al., 1993), an asymmetry index was computed as the log10 of alpha power at recording sites on the left minus those on the right for anterior (log10 F3 – log10 F4) and posterior regions (log10 P3 – log10 P4), averaged over eyes open and closed conditions. Since alpha power is thought to vary inversely with cortical activity (Shagass, 1972), lower values indicate greater left, relative to right, cortical activity.

Age seven assessment

At the third follow-up, children were an average of 7.0 years old (SD = 0.5). We attempted to collect follow-up data on the original sample of 100 children, and successfully obtained data for 64 children (32 males). Families who were and were not followed up from the baseline assessment did not differ on SES, and children who were and were not followed up did not differ on PE.

Helplessness. To obtain an index of helplessness in the interpersonal domain, children were told that they were going to be interviewed for admission to a club “just for kids” (Erdley, Loomis, Cain, & Dumas-Hines, 1997). An unfamiliar interviewer asked children a series of questions under the pretence that she needed to determine whether they would get along well with the other children in the club. The interviewer then told the child that
she was going to send his/her information to the president of the club by computer, so that the president could immediately decide whether the child would be admitted. After a brief delay, the assistant returned, stating that the president wasn’t sure about whether the child should get to be in the club, and that she/he wanted to know more about the child before deciding. Children were then allowed to choose whether they wanted to reapply to the club by providing more information about themselves.

Following the request for more information, children were asked several questions to assess their attributions for the ambiguous rejection (Erdley et al., 1997). These questions were introduced by telling the child that other children had certain thoughts when they heard the president wasn’t sure about letting them into the club. The experimenter told the child that these thoughts were: (1) Do other kids not like me? (2) Am I not good at making friends? (3) Am I not a fun kid to be around? and (4) Did I not try hard enough to get in to the club? Immediately after stating each “thought” to the child, the experimenter followed with the query, “Did you think that?” The episode ended when the assistant returned with a certificate of membership, explaining that she had made a mistake and that the child was accepted into the club from the very beginning.

Self-referent encoding task (SRET). Immediately after a mood-induction procedure to prime a negative mood state,1 children were presented with a series of 18 positive and 18 negative trait descriptions, shown to them printed on flashcards and spoken aloud by the experimenter, followed by a self-referent question (“Is this word like you?”). The positive and negative adjectives were matched for frequency and selected for grade 3 reading level (the lowest for which data were available). An unexpected incidental recall period immediately followed in which children were asked to recall as many of these trait words as possible for a maximum period of 3 minutes. The first and last three words from the list were not counted in order to eliminate primacy and recency effects. Positive and negative adjectives rated as self-descriptive were counted, and two additional scores were computed: a positive schematic processing score (the proportion of positive words rated self-descriptive and recalled relative to all words rated self-descriptive), and a negative schematic processing score (derived in the same manner).

1 Children were shown a sad clip from a children’s movie to induce a sad mood state. Raters blind to the purpose of the mood induction coded child facial affect video recorded during the procedure. Supporting the efficacy of the induction, children displayed significantly greater facial negative affect in the second half of the mood induction ($M = -1.40$, $SD = 0.48$) than in the first half ($M = -0.83$, $SD = 0.34$), $t(60) = 8.83$, $p < .001$, $d = 1.34$ (see Hayden et al., 2006, for further details).
Self-reported depression. As part of a subsequent home visit a mean 3.5 days later ($SD = 10.3$), children were orally administered the Depression Self-Rating Scale (DSRS; Birleson, 1981), a self-report measure of the affective, cognitive, behavioural, and somatic symptoms of depression. It has adequate internal consistency and test–retest reliability, and discriminates between children with and without depressive disorders (Asarnow & Carlson, 1985). Coefficient alpha for the DSRS in our sample was .75. The mean DSRS score for the present study was low ($M = 10.3$, $SD = 5.4$), and comparable to other non-clinical samples (Asarnow & Carlson, 1985). The reading subtest from the Wide Range Achievement Test (WRAT; Snelbaker, Wilkinson, Robertson, & Glutting, 2001) was also administered during the home visit.

Coding of age 7 laboratory tasks. Coders were blind to all study data collected at previous assessments. Whether children elected to reapply after the ambiguous rejection was coded as a dichotomous variable. Pieces of information children provided about themselves both prior to and following the ambiguous rejection were counted. Ratings of desire to join the club were made before and after the ambiguous rejection, as was an overall rating of desire to join the club. Difference scores using ratings derived from before and after the ambiguous rejection were created for the information counts and the desire to join ratings. As an index of the child’s effort invested in getting in the club, an overall rating of the complexity of the child’s self-description was also made, with concrete descriptors given by children (e.g., “I like riding my bike”) receiving lower scores than more complex descriptions (e.g., “My friends like me because I keep secrets if they ask me to”).

For the interpersonal helplessness task, the difference scores for the desire to join variable, the overall rating of desire to join, child self-description complexity, child self-reports of whether he/she thought he/she had tried hard enough, was fun to be around, and was good at making friends, and whether the child chose to reapply were included in the scale (alpha = .68). This variable was square-root transformed to address modest positive skewness. Interrater reliability, indexed by ICC, was assessed for a subset of 29 children from our sample. The ICC for the helplessness scale was .70.

From videotapes of the entire laboratory visit, behaviour and affect were coded by having raters watch episodes in their entirety and make a single rating for specific temperament dimensions based upon all relevant behaviours exhibited within a given episode. This coding system was similar to the global coding system used and described in previous work from our group, modified to be suitable for the present tasks (see Durbin, Hayden, Klein, & Olino, 2007, for further details). Briefly, ratings of facial positive affect (PA) for each episode were derived from judgements about the
frequency, intensity, and duration of smiling and laughter during each episode. Physical and verbal ratings of positive affect were also made, using behaviours such as excited jumping and verbalisations of positive content and/or tone. These three ratings were averaged into a single positive affect score for each task. Ratings of interest/engagement were made by considering factors such as time spent playing with laboratory stimuli and comments reflecting interest, such as questions about stimuli, and sociability ratings were made based on the children’s efforts to interact with the experimenter and research assistants during each task. Scores for child NE were derived using the same approach as the positive affect ratings, and were based on facial, physical, and verbal cues indicating sadness, anger, and fear. Ratings from each episode were summed across all episodes and scores were computed by taking the mean of these sums. Interrater reliability was assessed on a subsample of 29 participants. For the present study, measures of PA (\( \alpha = .94, \text{ICC} = .90 \)), interest/engagement (\( \alpha = .74, \text{ICC} = .57 \)), sociability (\( \alpha = .94, \text{ICC} = .90 \)) and NE (\( \alpha = .94, \text{ICC} = .89 \)) were used. To create a scale reflecting all facets of PE, the PA, interest, and sociability scales were \( z \)-transformed and averaged into a single PE scale (\( \alpha = .82 \)).

RESULTS

Twenty-two children had both EEG data from age 5–6 and cognitive styles and temperament data from age 7.\(^2\) Based on the age-3 temperament assessment, 10 of these children were from the lower PE group and 12 were from the higher PE group. Zero-order correlations between all major variables, as well as means and standard deviations, are presented in Table 1. Regardless of reference scheme, and consistent with the previous report from our group (Shankman et al., 2005), posterior asymmetry at age 5–6 reflecting greater left, relative to right, activity was associated with lower PE at age 7. Posterior indices of cortical asymmetry were not significantly related to child NE at age 7, and indices of anterior asymmetry were unrelated to child temperament and other study variables. Greater left, relative to right, posterior activity was associated with increased helplessness during the interpersonal helplessness task at the level of a trend. Neither anterior nor posterior cortical asymmetry was significantly related to performance on the SRET. Higher self-reported child depression was significantly correlated with greater helplessness during the interpersonal helplessness task, and, albeit without reaching significance, SRET scores, thus supporting the validity of these measures in terms of their relationship

\(^2\) Families for whom EEG and age 7 data were available were not significantly different from families with only EEG data on SES, \( t(26) = −1.65, p = .12 \).
### TABLE 1
Correlations between all major variables

<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>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Posterior asymmetry (P3–P4)</strong></td>
<td></td>
<td>.23</td>
<td>.06</td>
<td>.50*</td>
<td>.29</td>
<td>-.38†</td>
<td>.09</td>
<td>.10</td>
<td>.03</td>
<td>-.65**</td>
<td>.34</td>
</tr>
<tr>
<td><strong>Anterior asymmetry (F3–F4)</strong></td>
<td></td>
<td>.10</td>
<td>.01</td>
<td>.27</td>
<td>-.03</td>
<td>-.04</td>
<td>-.18</td>
<td>.24</td>
<td>-.16</td>
<td>.38†</td>
<td></td>
</tr>
<tr>
<td><strong>DSRS</strong></td>
<td></td>
<td>-.10</td>
<td>.12</td>
<td>.45*</td>
<td>-.32</td>
<td>.45*</td>
<td>-.10</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PE</strong></td>
<td></td>
<td>.08</td>
<td>-.69**</td>
<td>.21</td>
<td>.29</td>
<td>-.01</td>
<td>-.18</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NE</strong></td>
<td></td>
<td>.16</td>
<td>-.28</td>
<td>.17</td>
<td>.01</td>
<td>-.16</td>
<td>-.17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Interpers helplessness</strong></td>
<td></td>
<td>.16</td>
<td>.16</td>
<td>.01</td>
<td>.13</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SRET Pos</strong></td>
<td></td>
<td>.37†</td>
<td>-.37†</td>
<td>-.14</td>
<td>.04</td>
<td>.20</td>
<td>-.04</td>
<td>.27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SRET Neg</strong></td>
<td></td>
<td>-.31</td>
<td>-.23</td>
<td>-.05</td>
<td>.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td>.01</td>
<td>.13</td>
<td>.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td>-.15</td>
<td>-.15</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>WRAT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.27</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**M**

|       | 0.05 | 0.02 | 11.80 | -.01 | 3.11 | 1.43 | 0.17 | 0.05 | 7.07 |     | 26.35|

**SD**

|       | 0.08 | 0.05 | 5.27 | 3.10 | 0.88 | 0.23 | 0.10 | 0.06 | 0.48 |     | 4.74 |

Notes: “Sex” coded as 1 = male, 2 = female; DSRS = Depression Self-Rating Scale; PE = Positive Emotionality; NE = Negative Emotionality; SRET Pos = Self-Referent Encoding Task, Positive Composite; SRET Neg = Self-Referent Encoding Task, Negative Composite; WRAT = Wide-Range Achievement Task. *df = 20 except for correlations with the DSRS, for which *df = 19. †p < .10; *p < .05, **p < .01.
to depressive symptoms (see also Hayden et al., 2006). Female children had lower posterior asymmetry scores than males. Child age and WRAT scores were not significantly related to any major study variables.

To examine whether EEG measures collected at age 5 continued to predict age 7 PE and helplessness during the interpersonal helplessness task after controlling for the influence of potential confounding variables, hierarchical multiple regression was used. Results are presented in Table 2. For age 7 PE, child sex and self-reports of depression at age 7 were entered in Steps 1 and 2, respectively. Posterior asymmetry scores, entered at Step 3, contributed a significant increment to the model, indicating that greater left activity, relative to right, was associated with lower PE. A similar regression was used to examine whether posterior asymmetry would continue to predict behaviour during the interpersonal helplessness task. For this regression, child sex (Step 1) and self-reports of depression at age 7 (Step 2) were entered prior to entering posterior asymmetry at Step 3. Posterior asymmetry once again contributed significantly to the model, indicating that greater left than right activity was associated with greater helplessness.

**DISCUSSION**

We sought to extend previous research from our group by examining whether posterior asymmetry associated with child temperament in early childhood continued to be associated with child temperament at follow-up. We also examined whether posterior asymmetry was associated with cognitive vulnerability to depression later in development. We found that children with greater cortical activity in left, relative to right, posterior regions showed lower levels of PE and increased helplessness during a standardised laboratory task designed to elicit helplessness in an inter-
personal context at follow-up. This study had a number of strengths, including its longitudinal design and the use of laboratory measures of child temperament and helplessness. However, our study was limited by a small sample size. It may also be limited by attrition at age 7, and the group approach to sampling at age 5–6. We did not correct for multiple statistical tests in this exploratory study, but plan to examine whether these results replicate in ongoing work in our research program.

These findings extend the work of our group linking low PE to indices of depression risk (e.g., Durbin et al., 2005). Whereas our previous study (Shankman et al., 2005) showed that low PE and depression share similar patterns of regional cortical activity, the present study suggests a mechanism linking low PE and/or altered cortical activity to depression vulnerability—via their effects on cognitive and behavioural responses to mild stressors. Several eminent psychopathologists (e.g., Davidson et al., 2002; Meehl, 1975) have proposed that deficits in hedonic capacity lead to impaired responses to positive stimuli, perceived deficits in the reinforcing properties of stimuli, and a poor sense of mastery motivation. Hamburg (1998) argued that low positive emotionality eventually develops into a tendency to respond in helpless/hopeless ways when faced with even a mild challenge. Children with low PE and this pattern of cortical activity may hence fail to perceive social interactions as sufficiently “rewarding” to strive for success when presented with an obstacle. In other words, when confronted with signs that a goal may not be easily attained, such as the ambiguous rejection in our laboratory task, children with lower PE may not perceive outcomes as sufficiently positive to warrant the investment of additional efforts in the face of a mild setback. Of course, it is possible that the cognitive vulnerability measured at age 7 had already developed at earlier assessments, although it is unclear how this would be accurately assessed in younger children. We cannot argue that cortical asymmetry “caused” age 7 helplessness; both could be influenced by another, unmeasured variable or be different instantiations of a common underlying vulnerability to depression.

While posterior asymmetry showed modest associations with greater helplessness in a simulated interpersonal evaluative context, it was not associated with performance on the SRET. Although speculative, this is consistent with the aforementioned possibility that posterior asymmetry is associated with impairments discerning the affective significance of stimuli. The SRET stimuli were relatively straightforward in terms of valence, and may therefore be unrelated to the activity of brain systems that evaluate more ambiguous affective stimuli. On the other hand, interpersonal contexts are typically ambiguous, offering the possibility of both positive and negative outcomes. The effective functioning of systems that appraise the nature of such stimuli may therefore be more critical to behaviour in this context.
We also did not find an association between alpha asymmetry in anterior or posterior regions and depression in our sample, in contrast to other authors (Bruder et al., 1997; Davidson et al., 1987; Kentgen et al., 2000; Reid et al., 1998). This is likely due to the age of study participants, who were assessed in early childhood when rates of depression are low. It will be necessary to track larger samples well into the period of risk for depression to determine whether this index of cortical activity predicts an increased likelihood of depression onset over time.

Consistent with previous research from our group (Shankman et al., 2005), we did not find a relationship between anterior cortical asymmetry and child temperament. Based on the literature linking anterior asymmetry to various indices of depression risk (Gotlib et al., 1998; Henriques & Davidson, 1990) and approach-related behaviours (Harmon-Jones et al., 2002), associations between child temperament and frontal asymmetry might have been expected. Authors have argued that multiple assessments are needed to derive stable estimates of the “trait-like” component of anterior asymmetry, given the ample state effects on variance in resting EEG asymmetry as well (Hagemann, Hewig, Seifert, Naumann, & Bartussek, 2005). Had we aggregated multiple assessments of cortical activity over time, we might have found an association between child temperament and anterior EEG, although most other studies in the literature have used a one-time assessment such as ours. The fact that frontal alpha is more susceptible to noise than posterior alpha (Tenke & Kayser, 2005) may also have played a role in the lack of findings. It is also relevant that the emphasis of our work is on PE, whereas much of the previous work examining frontal cortical asymmetry in children has focused on behavioural inhibition, a trait reflecting wariness in novel situations. While this trait overlaps with PE, in that both traits emphasise approach-related behaviour, behavioural inhibition also captures anxious/fearful behaviours and is largely context dependent. Thus, there are substantial differences in the traits under examination in this study and most previous investigations.

To sum, greater activity in left, relative to right, posterior cortical regions was associated with temperamental and cognitive vulnerability to depression at follow-up in a community sample of children. These findings contribute to a growing literature (e.g., Bruder et al., 1997; Bruder et al., 2005; Davidson et al., 1987; Kentgen et al., 2000; Reid et al., 1998) suggesting that posterior asymmetry may play a role in vulnerability to depression.
REFERENCES


