BIS/BAS SCORES ARE CORRELATED WITH FRONTAL EEG ASYMMETRY IN INTRUSIVE AND WITHDRAWN DEPRESSED MOTHERS

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ABSTRACT: Differences between different style-depressed mothers, intrusive and withdrawn, were examined by the use of the Behavioral Inhibition and Activation Scales (BIS/BAS) and EEG activity from the mid-frontal and parietal regions. Analyses revealed that withdrawn mothers had left frontal EEG hypoactivation, higher Behavior Inhibition (BIS), and lower Behavior Activation (BAS) scores than the intrusive mothers. Further analysis revealed that the BIS, the BAS reward and the BAS-BIS difference scores were related to frontal EEG asymmetry and power scores. BIS scores were also related to the mothers' withdrawal interaction style, supporting the use of the BIS/BAS as a screening instrument to help identify intrusive and withdrawn depressed mothers.

RESUMEN: Se examinaron las diferencias entre los diferentes tipos de madres depresivas, las intrusas y las reservadas, usando para ello las Escalas de Inhibición y Activación de la Conducta (BIS/BAS) y la actividad EEG de las regiones medio frontal y parietal. Los análisis revelaron que las madres reservadas o aisladas presentaban una EEG hipoaactividad en el lado frontal izquierdo, y puntajes más altos de inhibiciones de conducta (BIS), y más bajos de activación de la conducta (BAS), que las madres intrusas. Los análisis posteriores revelaron que BIS, las recompensas de BAS, así como los puntajes de diferencia de BAS y BIS estaban todos relacionados con la asimetría frontal EEG y los puntajes de poder. Los puntajes BIS también fueron relacionados al tipo de interacción de las madres reservadas, lo cual apoya la idea de BIS/BAS como un instrumento de selección para ayudar a identificar madres depresivas, tanto las intrusas como aquellas de personalidad reservada.

RéSUMé : Les différences entre des mères déprimées de style différent, importunes et renfermées, ont été examinées par l'utilisation des Echelles de Comportement d’Inhibition et d’Activation (abrége BIS/BAS en anglais) et une activité électroencephalographique des régions parietales et mi-frontales. Les analyses

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Depressed mothers may exhibit different interaction styles, including withdrawn and intrusive styles, when interacting with their infants (Cohn, Campbell, Matias, & Hopkins, 1990; Field, Healy, Goldstein, & Guthertz, 1990) and with significant others (Hart, Field, Jones, & Yando, 1999). In one study withdrawn (under stimulating) mothers exhibited a more depressed state, more anxious affect, and fewer facial expressions during interactions than intrusive mothers (Jones et al., 1997). At a 1-year follow-up assessment they continued to score above the clinical cutoff for depression on the Beck Depression Inventory (Jones et al., 1997). Intrusive mothers had greater relative left frontal EEG activation at the 6-month postnatal assessment and reported fewer depressive symptoms (compared to withdrawn mothers) at the 1-year assessment (Jones et al., 1997).

Intrusive behavior, which is characterized by overstimulation and emotions such as anger, hostility, and irritability (Cohn, Matias, Tronik, Connell, & Lyons-Ruth, 1986; Field et al., 1990), may be the result of an overactive behavioral approach system (BAS). In contrast, withdrawn mothers are disengaged from their infants up to 80% of the time, responding to
them only when they are distressed (Cohn et al., 1986; Field et al., 1990), possibly as the result of an overactive behavioral inhibition system (BIS). The behavioral approach and inhibition systems, as proposed by Gray, are two hypothesized neurological systems underlying learning and affect (see Gray, 1994, for review). While the BAS is thought to be a reward-oriented system associated with approach behaviors and positive affect, the BIS is considered to be a punishment-oriented system associated with withdrawal behaviors and negative emotions (Gray, 1994).

Research has shown that individuals exhibiting overactive behavioral inhibition (i.e., withdrawal) are characterized by greater relative right frontal EEG alpha power asymmetry than individuals exhibiting overactive behavioral approach (i.e., intrusiveness) (Davidson, 1995; Harmon-Jones, Allen, 1997; Sutton & Davidson, 1997). Similarly contrasting EEG patterns have also been displayed by 3–6-month infants of depressed mothers with withdrawn and intrusive interaction styles (Jones et al., 1997). In the Jones et al. (1997) study, infants of withdrawn mothers showed greater relative right frontal EEG activation than infants of intrusive mothers, thus mimicking their mothers’ EEG patterns. Greater relative right frontal EEG asymmetry (as indicated by greater relative left frontal EEG hypoactivation) might reflect a depressed mood, and may be a biological marker for depression in adults (Henriques & Davidson, 1990, 1991) and has been consistently shown in infants of depressed mothers (Dawson, Frey, Pangorides, Osterling, & Hessol, 1997; Field, Fox, Pickens, & Nawrocki, 1995; Jones, Field, Fox, Davalos, Lundy, & Hart, 1998). In addition, greater relative right frontal EEG asymmetry may be related to negative emotionality (Fox, 1991), a finding consistent with the negative emotional valence proposed for withdrawal emotions and behavior (Gray, 1994).

Different interventions appear to be effective for intrusive versus withdrawn depressed mothers. For example, in a recent study, intrusive mothers coached to imitate their infants’ behaviors interacted more positively with their infants than intrusive mothers coached to elicit their infants’ attention (Malphurs et al., 1996). Withdrawn mothers on the other hand, had improved interactions when coached to “try to keep their infants’ attention.” Thus, identifying the mothers’ interaction style was important for selecting effective intervention strategies.

Maternal interaction style has typically been assessed by videotaping mother–infant interactions and then using a second-by-second time sample unit system to code intrusive/withdrawn interaction behaviors (Cohn et al., 1986; Field et al., 1990). While effective, the lengthy and complicated nature of behavior coding is not cost-effective and makes this an unviable screening tool. In addition, because newborns of depressed mothers already have profiles similar to their mothers at birth including behavioral (Abrams, Field, Scafidi, & Prodromidis, 1995; Lundy et al., 1999), physiological (Jones et al., 1998) and biochemical (Lundy et al., 1999) profiles, it is important for early intervention purposes to identify different maternal interaction styles before the 3–6-month period when mothers have been classified as withdrawn or intrusive interaction (Cohen et al., 1990; Field et al., 1990).

Short self-report questionnaires offer a viable alternative (Diego, Field & Hernandez-Reif, 2001; Wilcoz, Field, Prodromis, & Scafidi, 1998). Assessment of intrusive/withdrawn depressed interaction styles could involve the use of the CES-D (Radloff, 1977) to screen for depression and the BIS/BAS (Carver & White, 1994) scale to screen for interaction style. The BIS/BAS is a self-report measure designed to reflect differences in the individual’s behavioral approach and inhibition systems, and has been found to correlate with frontal EEG activation (Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997). In addition, BAS-BIS difference scores have been found to correlate with frontal EEG asymmetry (Sutton & Davidson, 1997).

The present study assessed the discriminative validity of the BIS/BAS for identifying intrusive versus withdrawn interaction style depressed mothers. Because the intrusive/withdrawn interaction styles have never been assessed with a self-report questionnaire, the present
study examined the relation between scores on the BIS/BAS scales and interaction style classifications derived from coding videotaped interactions. In addition, the present study assessed frontal EEG activation as an additional marker for intrusive/withdrawn interaction styles in depressed mothers.

Mothers with withdrawn interaction styles were expected to display greater relative right frontal EEG asymmetry than intrusive mothers. In addition, the withdrawn mothers were expected to have higher BIS (inhibition) scores and lower BAS (approach) scores, and the intrusive mothers were expected to have lower BIS scores and higher BAS scores. In addition BIS-BAS difference scores, intrusive/withdrawn styles, and EEG asymmetry scores were expected to be correlated.

METHOD

Participants

Ninety depressed mothers were recruited and screened for participation in this study. There were no significant demographic or CES-D differences between depressed mothers (n = 60) who participated in the study and the depressed mothers (N = 30) who could not be classified as intrusive or withdrawn and, therefore, were excluded from the study. The 60 intrusive (n = 35) and withdrawn (n = 25) depressed mothers (mean age = 25, SD = 5.1 years old) and their 3–6-month-old infants (mean age = 18 weeks, SD = 6.0) who participated in this study were distributed 65% African American, 18% Hispanic, and 17% Caucasian. Socio-economic status ranged from 20% middle-upper, 17% middle, 38% middle-lower, and 25% lower class (M Hollingshead = 3.96, SD = 1.06) (Hollingshead, 1975). The majority of the mothers were single (47%), 39% were married, and 14% were divorced.

Procedure

The mothers were recruited following informed consent from a larger sample of depressed mothers who had previously participated in a longitudinal study examining the effects of maternal depression on infant development. To be invited to participate in this study, infants had to be between 3 and 6 months of age and mothers had to have scored above 16, the cut-off score for depression (Weissman, Prusoff, & Newberry, 1977), on the Center for Epidemiological Studies Depression (CES-D) Inventory (Radloff, 1977) when their infants were 1 week old.

The mothers and their 3–6-month-old infants were videotaped for a 3-minute interaction. Upon completion of the interaction, the mothers were administered the BIS/BAS scales (Carver & White, 1994). Of the 90 mothers who had their interactions coded, 39% could be classified as intrusive, and 28% as withdrawn. Because we were only interested in investigating differences between intrusive and withdrawn depressed mothers, only mothers whose videotaped behaviors were coded as intrusive (n = 35) or withdrawn (n = 25) were included in this study and had their EEG recorded.

Assessments

Interaction style. For the purpose of determining the mothers' interaction style, mothers were instructed to play with their infants for three minutes in a face-to-face position as they normally
would at home, but without toys. The interaction was videotaped using a split-screen generator so that the mothers’ and their infants’ faces and upper body were observable.

The mothers’ physical, affective, and vocal behaviors were later coded from the videotape in 10-second time sampling units on paper grids. Mothers were classified as intrusive if they demonstrated physically intrusive behaviors including: rough tickling, poking, pulling, shaking, looming, and using brisk movements, during at least 50% of the time sample units. Mothers could also be classified as intrusive if they were physically intrusive during less than 50% of the time sample units but also demonstrated loud, noncontingent speech and exaggerated, fake, facial expressions. Mothers were classified as withdrawn if they had physical contacts with their infants less than 50% of the time sample units or touched them only inadvertently as in adjusting the infant’s clothing, during at least 50% of the interaction time. Mothers could also be classified as withdrawn if they had physical contact with their infants less than 50% of the time sample units but also demonstrated flat affect and minimal coherent speech. Interobserver reliability was conducted using two independent observers for 30% of the videotaped interactions (Kappa = .82). As already noted, only those mothers meeting intrusive or withdrawn criteria were included in the study.

The Center for Epidemiological Studies-Depression scale (CES-D) (Radloff, 1977) is a 20-item scale, with scores ranging between 0 and 60. The frequency (within the last week) is rated on 20 symptoms including depressed mood, feelings of helplessness and hopelessness, feelings of guilt and worthlessness, loss of energy, and sleep and appetite problems. A score of 16 or greater is considered the cutoff for depression, with only a 6% false positive and 36% false negative rate (Myers & Weissman, 1980). In addition, this scale has been shown to be reliable and valid for diverse demographic groups (Radloff, 1977).

The Behavioral Inhibition and Behavioral Approach System Questionnaire (BIS/ BAS) (Carver & White, 1994) is a 24-item questionnaire consisting of personal statements followed by four severity options ranging from very true to very false. The BIS/ BAS is designed to assess the tendency to behave in response to reward or in response to punishment. The Behavioral Inhibition System (BIS), examines behavior in response to punishment and the Behavioral Approach System (BAS) aspect of the questionnaire examines behavior in response to reward and is comprised of three scales, BAS fun, BAS reward, and BAS drive. Test retest reliability computed 8 weeks apart was .66 for the BIS, .66 for BAS Drive, .59 for the BAS Reward, and .69 for the BAS Fun scales. The BIS/BAS scales have adequate internal reliability (.66 to .74) and adequate convergent and divergent validity with other measures including the PANAS, LOT, MAS, GTS, and Eysenck’s Extroversion scale.

BAS-BIS difference scores were obtained by subtracting z-transformed BIS scores from z-transformed BAS scores. Positive scores denote greater BAS activity while negative scores denote greater BIS activity. This method has previously been used to analyze the relation between BIS/BAS scores and EEG activity (Sutton & Davidson, 1997).

A 3-minute EEG was recorded from the mid-frontal (F3 & F4) and parietal (P3 & P4) regions and referenced to the vertex (Cz). Omni-prep gel and electrode gel were inserted into each site to gently abrade and provide good conductance (D.O. Weaver & Co., Aurora, CO). Impedances were less than 5K ohms or the site was reabraded until optimal impedances were obtained. The vertex reference location was used because this reference site has been shown to produce comparable results to other reference sites (Tomarken, Davidson, Wheeler, & Kinney, 1992b). EEG was also obtained from the outer canthus and the supraorbital position of one eye using Beckman mini-electrodes.

The EEG signals were obtained using a Grass Model 12 Neurodata Acquisition System, and the output was directed to a Dell 325 D PC fitted with an Analog Devices RTI-815 A/D.
board. The sampling rate was 512 samples per second, and the data were streamed across the computer screen and then saved to a hard disk using data acquisition software (Snapstream, v. 3.21, HEM Data Corp. 1991).

EEG data were scored for eye and motor movement artifact using the EOG channels as cues, and the data containing artifact were underscored and eliminated from each channel. The data were submitted to a discrete Fourier Transform using a Hanning Window with 50% overlap. The analyses produced power for the Alpha 8–12-Hz band in picowatt ohms (one microvolt squared) for each channel. Alpha power values were then log transformed to normalize the distribution. We then computed frontal and parietal asymmetry scores using the natural log power scores. The asymmetry score is a difference score reflecting the power in one hemisphere relative to the power in the contralateral hemisphere (Ln (Right) – Ln (Left)), with negative scores reflecting greater relative right EEG activation and positive scores reflecting greater relative left EEG activation.

RESULTS

Differences Between Intrusive and Withdrawn Mothers

Demographic variables. Chi-square tests and analyses of variance (ANOVAs) were conducted on the demographic variables for intrusive and withdrawn mothers. The mothers did not differ on ethnicity, SES, maternal age, or marital status and infant gender and age.

Psychometric assessments. A significant MANOVA on the self-report scale scores, F(6,53) = 5.63, p < .001, revealed the following (see Table 1): (1) no group differences on CES-D scores, F(1,59) = .84, p > .1; (2) higher BIS scores for the withdrawn mothers, F(1,59) = 24.46, p < .001, suggesting greater inhibition; and (3) higher BAS reward, F(1,59) = 10.87, p < .05, BAS drive, F(1,59) = 3.93, p < .05, and BAS-BIS difference scores for the intrusive mothers, F(1,59) = 21.24, p < .001, suggesting greater approach activity.

Frontal EEG asymmetry scores. Due to movement artifact, valid EEG data were obtained from 57 of the 60 mothers (n = 2 Intrusive). A group (Intrusive/Withdrawn) by region (frontal/parietal) MANOVA conducted on EEG asymmetry scores (ln right – ln left) (Figure 1) yielded a significant group by region interaction effect, F(2,52) = 4.74, p < .05. Subsequent post hoc

| TABLE 1. Means for Self-Report Questionnaire Scores (Standard Deviations in Parentheses) |
|-----------------------------------------------|-----------------------------------------------|
| Intrusive (N = 25) | Withdrawn (N = 35) |
|----------------|
| CES-D | 23.37 (11.14) | 25.76 (7.89) |
| BIS-BIS difference† | 0.65 (1.30) | −3.91 (1.27) |
| BIS Total† | 19.11 (3.33) | 23.36 (3.20) |
| BIS Total | 42.60 (5.23) | 40.00 (4.56) |
| BAS Fun | 14.11 (3.07) | 15.12 (3.84) |
| BAS Reward* | 15.94 (3.03) | 13.32 (3.05) |
| BAS Drive* | 12.63 (2.18) | 11.52 (2.06) |

† p < .05, * p < .001.
ANOVA revealed that the withdrawn mothers had significantly greater relative right frontal EEG activation than the intrusive mothers, $F(1,53) = 9.65, p < .05$.

To better understand this effect we computed separate ANOVAs on Log alpha power scores for the left and right frontal regions for the intrusive and withdrawn mothers. These analyses yielded a significant group difference for the left frontal region, $F(1,55) = 4.01, p < .05$, but not the right frontal region, $F(1,55) = 1.46, n.s.$, suggesting that the greater right frontal EEG asymmetry seen in the withdrawn mothers was due to left frontal hypoactivation (Figure 2).

**Relations Between Assessments**

**EEG and BIS/BAS scores.** Correlation analyses were conducted to determine the relations between frontal EEG asymmetry, frontal EEG power, and BIS/BAS scores. Higher BIS scores were related to greater relative right frontal EEG activation ($r = - .27, p < .05$), whereas higher BAS reward scores were related to greater relative left frontal EEG activation ($r = .33, p < .05$) (Table 2). Similarly, there was a positive relation between EEG asymmetry and BIS-BAS difference scores ($r = .28, p < .05$) (Figure 3). The negative relationship between left ($r = -.29, p < .05$) but not right ($r = -.22, n.s.$) frontal EEG power and BIS-BAS difference scores and the positive relationship between left ($r = -.28, p < .05$) but not right ($r = .22, n.s.$) frontal EEG power and BIS score further indicates that left frontal hypoactivation is correlated with greater Behavioral Inhibition Scale scores while left frontal hyperactivation is correlated with greater Behavioral Approach Scale scores.
DISCUSSION

The findings from this study are consistent with previous research demonstrating that depressed mothers with withdrawn interaction styles exhibit greater relative right frontal EEG asymmetry than depressed mothers with intrusive interaction styles, and that this asymmetry is due to left frontal hypoactivation (Jones et al., 1997). That right frontal EEG activation (as indicated by left frontal hypoactivation) has been associated with a negative affect (Tomarken, Davidson, Wheeler, & Doss, 1992a), and is a possible marker for chronic depression (Henriques & Davidson, 1991), supports previous observations that withdrawn mothers rate themselves as being more depressed and interact less with their infants than intrusive mothers.

Frontal EEG asymmetry was also related to Behavioral Inhibition and Activation. Mothers

TABLE 2. Relations Between Frontal EEG Asymmetry, BIS/BAS Scores, and BAS-BIS Difference Scores

<table>
<thead>
<tr>
<th>Measure</th>
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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>1. Frontal EEG asymmetry</td>
<td></td>
<td></td>
<td>307*</td>
<td>394*</td>
<td></td>
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<tr>
<td>2. Left frontal power</td>
<td></td>
<td>0.74</td>
<td></td>
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<td>3. Right frontal power</td>
<td>2.78*</td>
<td>0.74</td>
<td>0.70</td>
<td>0.76</td>
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<td>4. BAS-BIS difference</td>
<td></td>
<td>0.27</td>
<td>0.28</td>
<td>0.21</td>
<td>0.74</td>
<td>0.32</td>
<td>0.22</td>
<td>0.27</td>
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<tr>
<td>5. BIS</td>
<td>0.27</td>
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<tr>
<td>6. BAS fun</td>
<td>0.13</td>
<td></td>
<td>0.50</td>
<td>0.60</td>
<td>0.49</td>
<td>0.26</td>
<td>0.27</td>
<td>0.39</td>
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<tr>
<td>7. BAS reward</td>
<td></td>
<td>0.32</td>
<td>0.22</td>
<td>0.46</td>
<td>0.25</td>
<td>0.27</td>
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<tr>
<td>8. BAS drive</td>
<td>0.03</td>
<td>0.50</td>
<td>0.60</td>
<td>0.59</td>
<td>0.26</td>
<td>0.27</td>
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* p < 0.05, † p < 0.01.
with high Behavioral Inhibition and low Behavioral Activation displayed greater relative right frontal EEG activation. This is consistent with previous studies (Harmon-Jones & Allen, 1997; Sutton & Davidson, 1997) and supports the role of the right prefrontal cortex in withdrawal behaviors and the left prefrontal cortex with approach behaviors. Likewise, these and previous data support the use of the BIS/BAS scales as an accurate means to determine behavioral approach and inhibition. That the withdrawn mothers showed less left frontal activation than the intrusive mothers suggests that the difference between these two interaction styles in depressed mothers may be due to a failure to engage rather than active withdrawal.

While most studies examining EEG asymmetry in depression have shown consistent findings, at least one study failed to replicate these results (Reid, Duke, & Allen, 1998). The reason suggested for this inconsistency were inconsistent statistical analyses and assignment of subjects to the depressed groups (Davidson, 1998). The difference in frontal EEG asymmetry seen in these intrusive and withdrawn mothers emphasizes the need to account for approach and withdrawal behaviors within depressed samples in the study and treatment of depression.

Maternal interaction style was also related to Behavioral Inhibition and Approach as reflected by BIS/BAS scale scores. As expected, withdrawn mothers had an overactive Behavioral Inhibition System and an underactive Behavioral Approach System. Intrusive mothers, on the other hand, had an underactive Behavioral Inhibition System and an overactive Behavioral Approach System. From these data we can determine that the BIS, BAS reward, and drive, and the BIS/BAS difference score may be useful as a screening tool for classifying depressed mothers as withdrawn or intrusive. The BIS/BAS scales may offer a viable alternative to waiting until 3–6 months for interaction behavior coding (the optimal time period for mother–infant interactions).
Because depressed mothers’ interaction style plays a significant role in their infants’ development, and because these interaction styles require different approaches to treatment, it is imperative to conduct further research in this area. Further research is needed to evaluate different treatment interventions. In addition, more research is needed to evaluate the impact of withdrawn/intrusive interaction styles on infant behavior and development.

In conclusion, withdrawn and intrusive depressed mothers exhibit contralateral anterior brain activity and have opposite Behavioral Inhibition and Behavioral Approach profiles as reflected by BIS/BAS scale scores. This evidence supports the use of Carver and White’s (1994) BIS/BAS scales as a cost- and time-effective instrument to help screen depressed mothers’ disposition towards withdrawn versus intrusive interaction style. As already noted, these different style mothers respond to different types of interventions, for example, an “imitation” intervention has been effective with intrusive mothers and a “trying-to-keep-your baby’s attention” intervention has been effective with withdrawn mothers (Malphurs et al., 1996). Using the BIS/BAS to screen for these different style mothers may help determine the types of early interventions that may be effective for the different style mothers.

REFERENCES


