Journal of Clinical Child & Adolescent Psychology, 00(00), 1–10, 2018

ISSN: 1537-4416 print/1537-4424 online
DOI: https://doi.org/10.1080/15374416.2018.1453365

Parental Expressed Emotion-Criticism and Neural Markers of Sustained Attention to Emotional Faces in Children

Kiera M. James
Center for Affective Science, Binghamton University (SUNY)

Max Owens
Department of Psychology, University of South Florida St. Petersburg

Mary L. Woody
Department of Psychiatry, University of Pittsburgh

Nathan T. Hall
Department of Psychology, Pennsylvania State University

Brandon E. Gibb
Center for Affective Science, Binghamton University (SUNY)

There is growing evidence for the role of environmental influences on children's information-processing biases for affectively salient stimuli. The goal of this study was to extend this research by examining the relation between parental criticism (expressed emotion-criticism, or EE-Crit) and children's processing of facial displays of emotion. Specifically, we examined the relation between EE-Crit and children's sensitivity in detecting facial displays of emotion. We also examined a neural marker of sustained attention, the late positive potential (LPP) event-related potential component (ERP). Participants were 87 children (ages 7–11 years; 53.3% female, 77.8% Caucasian) and their parents (ages 24–71; 90% female, 88.9% Caucasian). Parents completed the Five-Minute Speech Sample to determine levels of EE-Crit toward their child. Children completed a morphed faces task during which behavioral and ERP responses were assessed. Although there were no group differences in sensitivity in detecting facial displays of emotion, we found that children of parents exhibiting high, compared to low, EE-Crit displayed less attention (smaller LPP magnitudes) to all facial displays of emotion (fearful, happy, sad). These results suggest that children of critical parents may exhibit an avoidant pattern of attention to affectively-salient interpersonal stimuli.

According to cognitive models of psychopathology (e.g., Clark, Beck, & Alford, 1999; Williams, Watts, MacLeod, & Mathews, 1997), the ways in which individuals attend to, interpret, and remember information in their environment can contribute to the development and maintenance of various forms of psychopathology. Supporting these theories, there is considerable evidence for the role of disorder-specific information-processing biases in different forms of psychopathology (for reviews, see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van IJzendoorn, 2007; Gotlib & Joormann, 2010; Peckham, McHugh, & Otto, 2010). For example, research has supported the hypothesis that individuals with depression exhibit attentional biases for depression-relevant stimuli (e.g., sad faces; Gotlib & Joormann, 2010; Peckham et al., 2010),

Correspondence should be addressed to Kiera M. James, Department of Psychology, Binghamton University (SUNY), Binghamton, NY 13902-6000. E-mail: kjames16@binghamton.edu

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/hcap.

whereas those with anxiety disorders demonstrate attentional biases for threat-relevant stimuli (e.g., angry or fearful faces; Bar-Haim et al., 2007). Moreover, prospective studies suggest that these attentional biases are not simply correlates of psychopathology but also predictors of symptom change over time (Beevers & Carver, 2003; Gibb, Uhrlass, Grassia, Benas, & McGeary, 2009; Van Bockstaele et al., 2014). Further supporting the role of attention biases, a growing number of researchers have investigated computer-based attention retraining programs and have suggested that such programs may be effective treatments for anxiety and depression (Hakamata et al., 2010; Hallion & Ruscio, 2011; Kuckertz & Amir, 2015).

Despite the evidence for the importance of information-processing biases in risk for psychopathology, little is known about how they develop. Nonetheless, theorists have proposed that these biases develop during childhood and increase risk for psychopathology across the lifespan. Specifically, theorists have suggested that negative childhood experiences may contribute to the development of experience-specific biases in attention, interpretation, and memory for affectively-salient stimuli (see Cicchetti, Toth, & Maughan, 2000; Pollak, 2003; Rose & Abramson, 1992). Of particular relevance to the current project, theorists have proposed that children who are consistently exposed to threatening facial displays of emotion (e.g., anger) develop a hypervigilance for these cues so that the threat can be avoided (Cicchetti et al., 2000; Pollak, 2003). This biased processing of threat cues can take the form of increased sensitivity in detecting facial signs of threat or attentional biases for threat-relevant stimuli.

To date, most of the research examining environmental influences on children's information-processing biases has focused on the role of childhood physical abuse. This research has shown that children exposed to physical abuse display enhanced sensitivity in detecting facial displays of anger (Pollak & Kistler, 2002) and attentional biases specifically for threat-relevant stimuli (e.g., angry faces), but not for other stimuli (e.g., Pine et al., 2005; Pollak & Tolley-Schell, 2003). What remains unclear, however, is whether similar biases will be observed in less severe forms of parental behavior. Specifically, to the extent that the biases develop, at least in part, based on exposure to angry expressions from one's parents, then other forms of behavior such as expressed emotion-criticism (EE-Crit) should also be related to children's information-processing biases.

EE-Crit reflects the degree to which a parent is critical of, or hostile toward, his or her child. It is often assessed using the Five Minute Speech Sample (FMSS; Magaña et al., 1986) in which parents are asked to speak about their child for 5 min. Supporting the validity of this approach, levels of EE-Crit assessed using the FMSS are associated with observed levels of parents' criticism and anger toward their child during parent–child interactions (Cruise, Sheeber, & Tompson, 2011; Hermanns, Florin, Dietrich, Rieger, & Hahlweg, 1989; McCarty, Lau, Valeri, & Weisz, 2004). In addition, levels of EE-Crit assessed with the FMSS are associated with the presence of psychopathology in youth (Gar & Hudson, 2008; Silk et al., 2009) and prospectively predict risk for the future development of depression (Burkhouse, Uhrlass, Stone, Knopik, & Gibb, 2012; Silk et al., 2009). To date, however, no studies have examined the relation between EE-Crit and children's sensitivity in detecting facial displays of emotion, and only one study has examined the link between EE-Crit and children's attention biases. In this study, children exposed to high, compared to low, levels of EE-Crit exhibited an attentional bias specifically for angry but not for happy or sad faces (Gibb et al., 2011).

Despite the strengths of this study, a limitation of this study, as well as the majority of previous research examining attentional biases in children, is that it relied upon reaction time indices of attention bias. Specifically, the majority of these studies used a dot probe task (MacLeod, Mathews, & Tata, 1986) in which two faces —one neutral and one emotional—are presented on the screen at the same time. Following a brief presentation (typically 500–1,000 ms) the faces disappear and a probe appears in the place of one of the faces. The participant is asked to indicate the location or type of probe presented. It is assumed that reaction times to the probe will be quicker if the participant is already looking at that side of the screen. However, there is growing concern about the psychometric properties of this type of reaction time index of attention bias, with many studies finding low, or even negative, split-half reliability values for these indices (for reviews, see Gibb, Mcgeary, & Beevers, 2016; Price et al., 2015). Perhaps because of such reliance on reaction time indices of attention, although research using these indices has been consistent in suggesting that physical abuse and EE-Crit are associated with attention biases specifically for threat-relevant stimuli, findings have been mixed with regard to the direction of the bias. Indeed, some studies demonstrate evidence for increased attention to threat-relevant stimuli (Gibb, Schofield, & Coles, 2009; Pollak & Tolley-Schell, 2003) and others demonstrate evidence for less attention to threat-relevant stimuli (Gibb et al., 2011; Johnson, Gibb, & McGeary, 2010; Pine et al., 2005) among children with a history of physical abuse or EE-Crit.

More recently, therefore, researchers have focused on more direct neural measures of attentional allocation, including event-related potentials (ERPs). In particular, one ERP component, the late positive potential (LPP), is a measure of sustained attention to affectively-salient visual stimuli (Hajcak, Weinberg, MacNamara, & Foti, 2012). A number of studies have shown that individuals exhibit larger LPPs for emotionally salient stimuli than neutral stimuli (Cuthbert, Schupp, Bradley, Birbaumer, & Lang, 2000; Ferrari, Codispoti, Cardinale, & Bradley, 2008; Hajcak & Olvet, 2008; for a review, see Lang & Bradley, 2010). In addition, although previous research has supported the link between LPP reactivity to emotional stimuli and psychopathology, including symptoms and diagnoses of both depression and anxiety (Dennis & Hajcak, 2009; Holmes, Nielsen, & Green, 2008; MacNamara & Hajcak, 2010; Weinberg & Hajcak, 2011), no study of which we are aware has examined the link between EE-Crit and LPP magnitudes for emotional stimuli.

Thus, the goal of the current study was to assess the relation between exposure to parental criticism (EE-Crit) and biases in children's processing of facial displays of emotion. Specifically, we examined children's sensitivity in detecting facial displays of emotion as well as their attentional biases for these faces. We predicted that children of critical parents would exhibit increased sensitivity in detecting threat-relevant stimuli (i.e., correctly identify the threat-relevant facial expressions at a lower morph intensity). We also predicted that children of critical parents would exhibit attentional biases for threat-relevant expressions. In addition, we predicted that the findings would be stronger for threat-relevant stimuli than for other facial expressions (happy or sad faces). However, based on the mixed findings from previous research (Gibb et al., 2011; Pine et al., 2005; Pollak & Tolley-Schell, 2003), we did not make specific predictions about whether this attentional bias would be exhibited as greater versus less attention, particularly given the range of methodology used in existing research. Finally, we examined whether these relations would be at least partially independent of children's current depressive and anxiety symptoms.

METHOD

Participants

Participants in this study were 87 children ages 7–11 and their biological parents recruited from the community as part of a larger study. This age range was selected because it provides an opportunity to examine information-processing biases prior to the surge in rates of psychopathology that occur during adolescence. For children in our sample, the average age was 9.79 years (*SD* = 1.46), and 52.9% were female. In terms of children's race, 78.2% were Caucasian, 6.9% were African American, 1.1% were Asian or Pacific Islanders, and 13.8% were biracial. The average age of parents in our sample was 38.19 years (*SD* = 8.73, range = 24–71), and 89.7% were female. In terms of parents' race, 88.5% were Caucasian, 8.0% were African American, 1.1% were Asian or Pacific Islanders, and 2.3% were biracial. The median annual family income was $30,000 to $35,000.

Measures

Morphed Faces Task

Children completed a morphed faces task (cf. Burkhouse, Siegle, & Gibb, 2014) in which they viewed gray-scaled faces from a standardized stimulus set of child actors 10–17 years of age from the National Institute of Mental Health Child Emotional Faces Picture Set (Egger et al., 2011) displaying a variety of emotions (fearful, happy, sad, neutral). The stimuli consisted of emotional and neutral photographs from each actor, morphed to form a continuum of 10% increments between the two photographs (see Figure 1). Eleven morphed images were used from each continuum (e.g., 100% neutral, 0% fearful; 90% neutral, 10% fearful; 80% neutral, 20% fearful, etc.), representing 10% increments of the two emotions ranging from 100% neutral (0% target emotion) to 100% target emotion (0% neutral). Morphed images were viewed as individual stimuli at different intensities of emotion. Each emotion was represented by four continua (two male and two female actors), for a total of 12 continua. The pictures were presented, one at a time in the middle of the screen for 3 s, after which they disappeared and the participant was asked to indicate which emotion was being presented using the following four response options for each image: fear, happy, sad, calm/relaxed. Each face was 26.5 cm tall (16° visual angle) × 16.5 cm wide (10° visual angle). The intertrial interval varied randomly between 500 and 750 ms. The stimuli were presented in semirandom order with the condition that no two images from the same actor were presented consecutively. Each of the 132 images was presented twice for a total of 264 trials, with a rest after every 55 trials. Consistent with previous research (e.g., Burkhouse et al., 2014; Burkhouse, Siegle, Woody, Kudinova, & Gibb, 2015), responses were binned into three separate morph conditions for analyses: low (10%, 20%, and 30%), medium (40%, 50%, 60%, and 70%), and high (80%, 90%, and 100%). To measure sensitivity to identification of emotional expressions, we calculated the proportion of times the child correctly identified the target emotion (fearful, happy, or sad) per level of morph.

EEG Data Recording and Analysis

Continuous EEG was recorded during the morphed faces task using a custom cap and the BioSemi ActiveTwo system. The signal was preamplified at the electrode with a gain of 16x; the EEG was digitized at

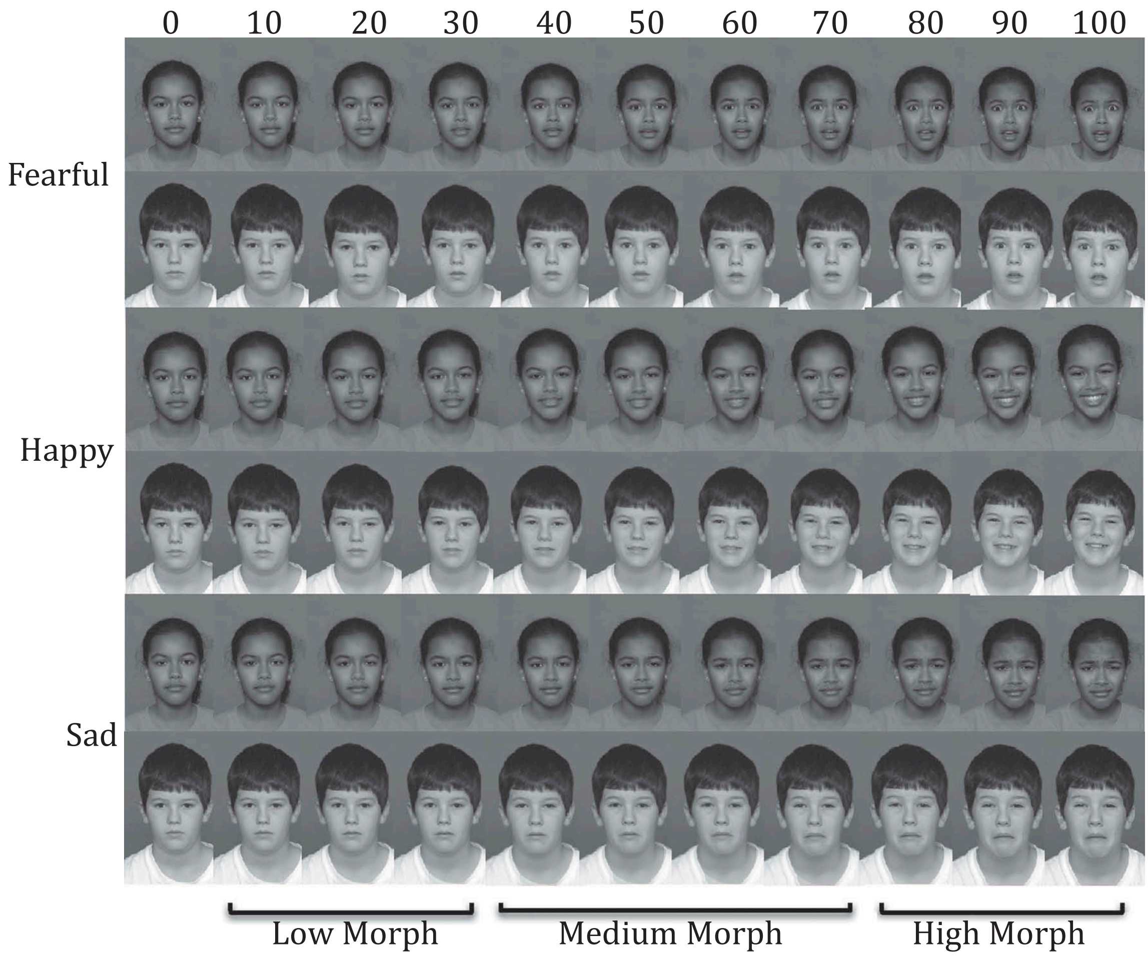

FIGURE 1 Example stimuli. *Note*: Each emotion was represented by four children (two male, two female). Morphed images were created using emotional and neutral photographs from each child to represent a continuum of 10% increments between the two photographs. Each stimulus was presented twice over the course of the task. Given the use of photographs from four children (two male, two female), the low-morph bin included 24 trials for each emotion, the medium morph bin included 32 trials for each emotion, and the high-morph bin included 24 trials for each emotion. Neutral stimuli (0% emotion) were presented for each continuum such that there were eight neutral trials for each emotion continuum (24 total neutral trials).

24-bit resolution with a sampling rate of 512 Hz using a low-pass fifth-order sinc filter with a half-power cutoff of 104 Hz. Recordings were taken from 34 scalp electrodes based on the 10/20 system. Two additional electrodes, an active (Common Mode Sense [CMS] and a passive Driven Right Leg (DRL) electrode were used in the study. Raw EEG was recorded relative to CMS. The CMS/DRL electrodes replaced the ground for recordings through a feedback loop which drove the average potential of the subject (i.e., the Common Mode voltage) as close as possible to the "zero" ADC reference voltage in the AD-box (please see http://www.biosemi.com/faq/cms&drl.htm for further details). In addition, the electrooculogram was recorded from four facial electrodes.

Off-line EEG analysis was performed using the MATLAB extension EEGLAB (Delorme & Makeig, 2004) and the EEGLAB plug-in ERPLAB (Lopez-Calderon & Luck, 2014). All data were band-pass filtered with cutoffs of 0.1 Hz and 30 Hz and re-referenced to the average of the left and right mastoid electrodes. EEG data were processed using both artifact rejection and correction. First, large and stereotypical ocular components were identified and removed using independent component analysis scalp maps (Jung et al., 2001). Epochs were then extracted from raw EEG with the interval from −200 ms to 0 ms serving as the baseline for each trial. Epochs with large artifacts (greater than 200 μV) were excluded from analysis. Participants with more than 50% of trial rejected were excluded from analysis. The number of rejected trials for each participant in each emotion/morph condition ranged from 0 to 6 (0%–25% of total trials) with an average of 1.52 trials rejected in each emotion/morph condition and the number of rejected trials not differing between the EE-Crit groups for any emotion/morph condition. Given that the LPP is localized more occipitally in children than in adults and consistent with previous studies measuring LPP responses in youth (Dennis & Hajcak, 2009; Kujawa, Klein, & Hajcak, 2012), the LPP was scored as the mean activity from 400ms to 1,000 ms after stimulus onset at a cluster of occipital (O1, O2, Oz) and parietal (P3, P4, PO3, PO4, Pz) electrode sites (e.g., Kujawa et al., 2016, 2016). The split-half reliability for LPP responses to each emotion was acceptable (fearful: α = .69; happy: α = .78; sad: α = .74). Consistent with past research (e.g., Weinberg, Venables, Proudfit, & Patrick, 2013), analyses focused on residual scores calculated from regression analyses in which the LPP response to neutral stimuli (0% morph) was used to predict the LPP response to each morph condition (low, medium, high) for each emotion, allowing us to focus specifically on LPP reactivity to emotional stimuli rather than LPP responses to faces more generally. Supporting this approach, there was no group difference in children's response to neutral stimuli, $t(88) = -0.23$, $p = .82$, $r_{effect\ size} = .03$.

Expressed Emotion-Criticism

Parents' levels of EE-Crit was assessed suing the FMSS (Magaña et al., 1986). During administration of the FMSS, the parent is asked to talk, uninterrupted, for 5 min about their child and how the parent and child get along together. The sample is recorded and coded for levels of EE-Crit by an independent rater. High EE-Crit ratings are given to parents if any of the following criteria are met: Their initial statement about the child is negative, they report a negative relationship, or they state one or more criticisms as defined by the FMSS coding system (e.g., s/he drives me crazy; s/he is annoying). Parents are assigned borderline critical ratings if they express dissatisfaction with the child in a manner that is not severe enough to be considered a criticism. Speech samples were assigned values of 2, 1, and 0 to reflect high, borderline-high, and low EE-Crit, respectively. Consistent with recommendations based on evidence that the FMSS tends toward underidentifying critical individuals (Hooley & Parker, 2006), responses were dichotomized such that parents exhibiting borderline or high EE-Crit (n = 24) were compared to those exhibiting low EE-Crit (n = 63). Numerous studies demonstrate support for the reliability and validity of the FMSS EE-Crit subscale (e.g., Asarnow, Tompson, Woo, & Cantwell, 2001; Burkhouse et al., 2012; Magaña et al., 1986; McCarty et al., 2004; Rogosch, Cicchetti, & Toth, 2004; Silk et al., 2009). In this study, speech samples were coded by individuals trained to reliability standards. These individuals were also blind to the other study variables. All samples were independently coded by two raters, and, when discrepancies arose, a third rater was consulted so that a consensus rating could be reached. Interrater reliability was assessed using a subset of 40 speech samples; the reliability of EE-Crit ratings was good (κ = .90).

Symptoms

Children's depressive and anxiety symptoms were assessed using the Children's Depression Inventory (CDI; Kovacs, 1981) and Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997). In the current study, the internal consistency (α) of the CDI and MASC were .74 and .88, respectively.

Procedure

Upon arrival at the laboratory, parents were asked to provide informed consent and children were asked to provide assent to be in the study. Immediately after consent, the parent completed the FMSS. Following this, parents and their children completed the diagnostic interview and questionnaire assessments, and children completed a series of computer tasks including the morphed faces task. As part of the larger study, parents were compensated $80 and children received a $10 gift card to a local store.

Ethical Considerations

All study procedures were approved by the university's Institutional Review Board. Prior to participation in the study, written informed consent was obtained from parents and written informed assent was obtained from children.

RESULTS

A preliminary inspection of the data revealed several variables that were significantly skewed ($z > 3.29$; cf. Tabachnick & Fidell, 2007). To satisfy the assumptions

TABLE 1
Means and Standard Deviations for Study Variables for Each Group of Children

	Low EE-Crit[a]	*High EE-Crit*[b]	F/χ^2
Child Age	9.52 (1.49)	10.48 (1.15)	3.18
Child Sex (% Girls)	57.1%	41.7%	1.67
Child Race (% Caucasian)	74.6%	87.5%	1.69
Parent Age	37.25 (7.86)	40.52 (10.22)	.60
Parent Sex (% Female)	93.7%	79.2%	3.93*
Parent Race (% Caucasian)	84.1%	100%	4.30*
CDI	5.26 (4.49)	5.42 (3.54)	2.48
MASC	45.57 (16.44)	39.13 (14.78)	1.44

Note: EE-Crit = expressed emotion-criticism; CDI = Children's Depression Inventory; MASC = Multidimensional Anxiety Scale for Children.

[a]n = 64.

[b]n = 23.

*p < .05.

of normality, these variables were transformed before any further analyses (square root: CDI, MASC). There was also some missing data, with up to 9.0% missing for any single variable. Given the presence of missing data, we examined whether the data were missing at random, thereby justifying the use of data imputation methods for estimating missing values (cf. Schafer & Graham, 2002). Little's Missing Completely at Random test, for which the null hypothesis is that the data are missing completely at random (Little & Rubin, 1987) was nonsignificant, $\chi^2(68) = 74.4$, $p = .28$, providing support for the imputation of missing values. Therefore, maximum likelihood estimates of missing values were created and used in all subsequent analyses (see Schafer & Graham, 2002). Means and standard deviations for all study variables are presented in Table 1. To facilitate comparison with other studies, values presented in the table are based on untransformed data.

Focusing first on children's sensitivity in detecting facial displays of emotion, we conducted a 2 (EE-Crit: low, high) × 3 (target emotion: fearful, happy, and sad) × 3 (morph level: low, medium, high) repeated measures analysis of variance with proportion of faces correctly identified per level of morph serving as the dependent variable. None of the main or interactive effects with EE-Crit were significant (lowest $p = .41$). However, there were significant main effects of target emotion, $F(2, 170) = 5.28$, $p < .01$, $\eta_p^2 = .06$, and morph level, $F(2, 170) = 1387.76$, $p < .001$, $\eta_p^2 = .94$. Examining the main effect of target emotion, collapsing across all morph levels, children were more sensitive in the detection of fearful ($M = .74$, $SE < .01$) and happy faces ($M = .73$, $SE = .01$) than sad faces ($M = .70$, $SE = .01$; $ps < .05$), with no significant difference in the recognition of fearful versus happy faces ($p = .43$). Examining the main effect of morph level, collapsing across emotions, children were significantly more accurate at each increasing morph level from low ($M = .30$, $SE = .02$) to

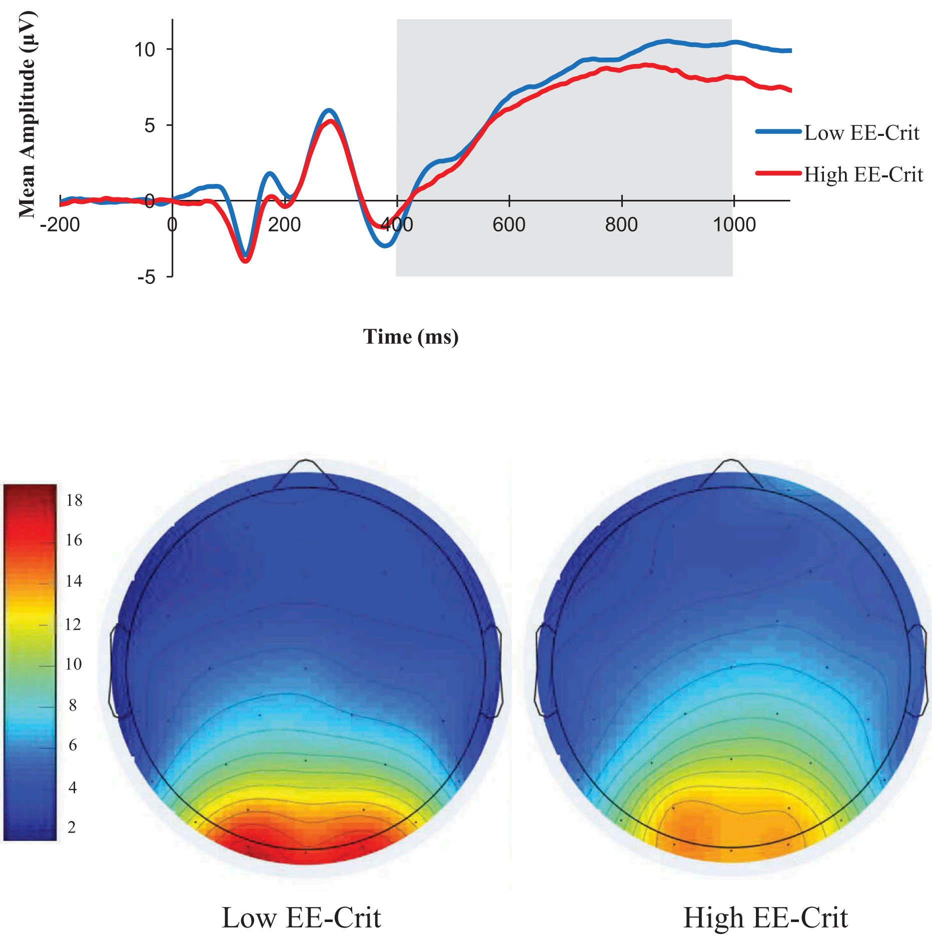

FIGURE 2 (Upper) Differences in grand-averaged late positive potential (LPP) waveforms collapsed across all emotional facial expressions (i.e., fearful, happy, sad) for children with high expressed emotion-criticism (EE-Crit) parents versus those low EE-Crit parents. The highlighted area shows the measurement window for the LPP (400–1,000 ms after stimulus onset). (Lower) Topographic scalp map for the LPP ERP component (400–1,000 ms after stimulus onset). See online article for the color version of this figure.

medium (M = .90, SE < .01) to high (M = .97, SE < .01; ps < .001). There was also a significant Target Emotion × Morph Level interaction, $F(4, 340) = 8.59$, $p < .001$, $\eta_p^2 = .09$. Examining the form of this interaction, we looked at the main effect of target emotion separately for each of the three morph levels. The main effect of target emotion was significant at the medium morph level, $F(2, 170) = 28.60$, $p < .001$, $\eta_p^2 = .25$, but not at the low, $F(2, 170) = 0.20$, $p = .83$, $\eta_p^2 = .002$, or high, $F(2, 170) = 0.37$, $p = .69$, $\eta_p^2 = .004$, morph level. At the medium morph level, recognition rates for each emotion differed significantly (fearful: M = .95; happy: M = .91; sad: M = .84; all ps < .01).

Next, to examine children's attentional biases, we conducted a 2 (EE-crit: low, high) × 3 (target emotion: fearful, happy, and sad) × 3 (morph level: low, medium, high) repeated measures analysis of variance with children's residualized LPP amplitudes serving as the dependent variable. The three-way interaction was not significant, $F(4, 340) = .30$, $p = .88$, $\eta_p^2 < .01$, and there were no significant main or interactive effects with emotion or morph (lowest p = .19). However, there was a significant main effect of EE-Crit, $F(1, 85) = 8.07$, $p < .01$, $\eta_p^2 = .09$, such that children exposed to high EE-Crit parents displayed lower LPP magnitudes to all emotions across all morph levels (M = −2.02, SE = 0.86) than children of low EE-Crit parents (M = 0.84, SE = .53). These findings are displayed in Figure 2.

Finally, we examined the robustness of the EE-Crit difference in LPP magnitudes. First, we tested whether it would be maintained after statistically controlling for the impact of children's current depressive and anxiety symptoms. The main effect of EE-Crit was maintained even after entering current depressive symptoms, $F(1, 84) = 8.08$, $p < .01$, $\eta_p^2 = .09$, and anxiety symptoms, $F(1, 84) = 8.93$, $p < .01$, $\eta_p^2 = .10$. Given that the majority of participating parents were mothers, we should also note that the main effect of EE-Crit was also maintained when analyses were limited to children who participated in the study with their biological mother, $F(1, 77) = 7.08$, $p < .01$, $\eta_p^2 = .08$.

DISCUSSION

The primary goal of this study was to examine the relation between exposure to parental EE-Crit and biases in children's processing of facial displays of emotion. Specifically, the study focused on children's sensitivity in detecting facial displays of emotion as well as on children's attentional biases for those facial displays of emotion. Contrary to our hypothesis, children of high EE-Crit parents were no better at detecting facial displays of any emotion than children with low EE-Crit parents at any of the morph levels. We did, however, find evidence of attentional biases. Specifically, children of high EE-Crit parents exhibited less sustained attention (smaller LPP magnitudes) to all emotional faces than did children of low EE-Crit parents. These results were maintained when statistically controlling for children's symptoms of anxiety and depression, suggesting that our findings are at least partially independent of children's symptoms.

Therefore, although children of high EE-Crit parents performed similarly to children of low EE-Crit parents in identifying emotions, suggesting that these children were indeed processing the facial stimuli, children of high EE-Crit parents exhibited less sustained attention to all emotions than children of low EE-Crit parents. These results are consistent with previous research that suggests children of high EE-Crit parents exhibit less attention to threat-relevant stimuli (Gibb et al., 2011). However, they differ from existing research in showing that the effects are not specific to threat-relevant information but rather extend across a range of emotional stimuli. Although the precise reason for this difference in findings is not clear, there are at least three potential explanations. First, whereas previous research has relied upon reaction time indices of attentional allocation, the current study focused on the LPP ERP component as a neural marker of sustained attention. Second, in contrast to earlier research that used facial displays of emotion from adults, the current study used facial displays of emotion from children. It is possible that attentional biases are more specific for adult facial displays of emotion as such biases may reflect conditioned responses to facial displays of anger from an adult (cf. Pischek-Simpson, Boschen, Neumann, & Waters, 2009), whereas biases for self-referent stimuli (child faces) may be broader. Finally, in the task used in the current study, one face was presented on the screen at a time. In contrast, previous research has primarily focused on tasks like the dot probe task (MacLeod et al., 1986) in which two faces appear on the screen simultaneously (one emotional and one neutral from the same actor). Given the variety of tasks used across studies, it is important to consider that different patterns of attentional bias may be observed in conditions in which there is competition between stimuli for attention.

The pattern of results observed in this study in which children with a critical parent exhibit reduced attention to emotional stimuli is consistent with emotional regulation models in which attentional deployment is hypothesized as an early developing emotion regulation strategy (Gross, 2014). It is also consistent with previous research suggesting that those exposed to high levels of parental criticism are more likely to use avoidant coping strategies (Cheavens et al., 2005). Given the cross-sectional design of the current study, however, future research is needed to clarify the impact of EE-

Crit on prospective changes in children's attentional biases and how this relation may affect later functioning.

The current study displayed several strengths, including a relatively large sample size, a multimethod assessment approach to examine the hypotheses, and the use of interviewer-coded levels of EE-Crit, which helps to extend previous research on this topic. Nonetheless, despite these strengths, there are some limitations to this study, which highlight areas for future research. The primary limitation of this study is its cross-sectional design. As a result, and as just noted, we cannot determine whether exposure to parental criticism is a cause, consequence, or simple correlate of attentional biases. Although we predict that exposure to parental criticism contributes to the development of attentional biases and framed our study in line with this prediction based on existing theories (see Cicchetti et al., 2000; Pollak, 2003; Rose & Abramson, 1992), it is important to note that it is also possible that children who demonstrate less attention across emotions elicit more criticism from their parents. This alternative possibility may be bolstered by the fact that the results of the current study suggest that children with a critical parent exhibit a general attentional bias across all emotions. Nonetheless, longitudinal studies that strive to establish temporal precedence are necessary to fully understand the nature of this relation. A secondary limitation of the current study, particularly in juxtaposition to extant research is its exclusion of angry faces as possible stimuli. To aid with comparison to past research and understand attentional allocation across forms of threat-relevant stimuli, future research should include both fearful and angry faces as stimulus. Finally, and similar to the previous limitation, given the present study's use of self-referent stimuli when previous research utilized adult faces, it is difficult to know if the differences in our findings are a result of our methodology or another factor. Accordingly, future studies should incorporate multiple tasks to assess attention administered to the same participants to determine whether these differences in attentional biases are a factor of stimulus type (adult vs. child faces).

FUNDING

This research was supported by the National Institute of Mental Health grant MH098060 awarded to B.E. Gibb. The authors thank Katie Burkhouse, Anastacia Kudinova, Aliona Tsypes, Cope Feurer, Sydney Meadows, Michael Van Wie, Devra Alper, Eric Funk, Effua Sosoo, Nathan Hall, Aholibama Lopez, and Kristina Wong for their help in conducting assessments for this project.

ORCID

Kiera M. James http://orcid.org/0000-0003-4685-2156
Mary L. Woody http://orcid.org/0000-0002-3021-3299
Nathan T. Hall http://orcid.org/0000-0003-4598-8123

REFERENCES

Asarnow, J. R., Tompson, M., Woo, S., & Cantwell, D. P. (2001). Is expressed emotion a specific risk factor for depression or a nonspecific correlate of psychopathology?. *Journal of Abnormal Child Psychology*, *29*(6), 573–583. doi:10.1023/A:1012237411007

Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, *133*(1), 1–24. doi:10.1037/0033-2909.133.1.1

Beevers, C. G., & Carver, C. S. (2003). Attentional bias and mood persistence as prospective predictors of dysphoria. *Cognitive Therapy and Research*, *27*(6), 619–637. doi:10.1023/A:1026347610928

Burkhouse, K. L., Siegle, G. J., & Gibb, B. E. (2014). Pupillary reactivity to emotional stimuli in children of depressed and anxious mothers. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *55*(9), 1009–1016. doi:10.1111/jcpp.12225

Burkhouse, K. L., Siegle, G. J., Woody, M. L., Kudinova, A. Y., & Gibb, B. E. (2015). Pupillary reactivity to sad stimuli as a biomarker of depression risk: Evidence from a prospective study of children. *Journal of Abnormal Psychology*, *124*(3), 498–506. doi:10.1037/abn0000072

Burkhouse, K. L., Uhrlass, D. J., Stone, L. B., Knopik, V. S., & Gibb, B. E. (2012). Expressed emotion-criticism and risk of depression onset in children. *Journal of Clinical Child & Adolescent Psychology*, *41*(6), 771–777. doi:10.1080/15374416.2012.703122

Cheavens, J. S., Zachary Rosenthal, M., Daughters, S. B., Nowak, J., Kosson, D., Lynch, T. R., & Lejuez, C. W. (2005). An analogue investigation of the relationships among perceived parental criticism, negative affect, and borderline personality disorder features: The role of thought suppression. *Behaviour Research and Therapy*, *43*(2), 257–268. doi:10.1016/j.brat.2004.01.006

Cicchetti, D., Toth, S.L., & Maughan, A. (2000). An ecological-transactional model of child maltreatment. In A.J. Sameroff, M. Lewis, & S.M. Miller (Eds.), *Handbook of developmental psychopathology.* Boston, MA: Springer. doi:10.1007/978-1-4615-4163-9_37

Clark, D. A., Beck, A. T., & Alford, B. A. (1999). *Scientific foundations of cognitive theory and therapy of depression*. New York, NY: John Wiley & Sons.

Cruise, R. C., Sheeber, L. B., & Tompson, M. C. (2011). Behavioral correlates of maternal expressed emotion in interaction tasks. *Journal of Family Psychology*, *25*(5), 781–784. doi:10.1037/a0024699

Cuthbert, B. N., Schupp, H. T., Bradley, M. M., Birbaumer, N., & Lang, P. J. (2000). Brain potentials in affective picture processing: Covariation with autonomic arousal and affective report. *Biological Psychology*, *52*(2), 95–111. doi:10.1016/S0301-0511(99)00044-7

Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. *Journal of Neuroscience Methods*, *134*(1), 9–21. doi:10.1016/j.jneumeth.2003.10.009

Dennis, T. A., & Hajcak, G. (2009). The late positive potential: A neurophysiological marker for emotion regulation in children. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, *50*(11), 1373–1383. doi:10.1111/j.1469-7610.2009.02168.x

Egger, H. L., Pine, D. S., Nelson, E., Leibenluft, E., Ernst, M., Towbin, K. E., & Angold, A. (2011). The NIMH child emotional faces picture set (NIMH-ChEFS): A new set of children's facial emotion stimuli. *International Journal of Methods in Psychiatric Research*, *20*(3), 145–156. doi:10.1002/mpr.343

Ferrari, V., Codispoti, M., Cardinale, R., & Bradley, M. M. (2008). Directed and motivated attention during processing of natural scenes. *Journal of Cognitive Neuroscience*, *20*(10), 1753–1761. doi:10.1162/jocn.2008.20121

Gar, N. S., & Hudson, J. L. (2008). An examination of the interactions between mothers and children with anxiety disorders. *Behaviour Research and Therapy*, *46*(12), 1266–1274. doi:10.1016/j.brat.2008.08.006

Gibb, B. E., Johnson, A. L., Benas, J. S., Uhrlass, D. J., Knopik, V. S., & McGeary, J. E. (2011). Children's 5-HTTLPR genotype moderates the link between maternal criticism and attentional biases specifically for facial displays of anger. *Cognition & Emotion*, *25*(6), 1104–1120. doi:10.1080/02699931.2010.508267

Gibb, B. E., Mcgeary, J. E., & Beevers, C. G. (2016). Attentional biases to emotional stimuli: Key components of the RDoC constructs of sustained threat and loss. *American Journal of Medical Genetics, Part B: Neuropsychiatric Genetics*, *171*(1), 65–80. doi:10.1002/ajmg.b.32383

Gibb, B. E., Schofield, C. A., & Coles, M. E. (2009). Reported history of childhood abuse and young adults' information-processing biases for facial displays of emotion. *Child Maltreatment*, *14*(2), 148–156. doi:10.1177/1077559508326358

Gibb, B. E., Uhrlass, D. J., Grassia, M., Benas, J. S., & McGeary, J. (2009). Children's inferential styles, 5-HTTLPR genotype, and maternal expressed emotion-criticism: An integrated model for the intergenerational transmission of depression. *Journal of Abnormal Psychology*, *118*(4), 734–745. doi:10.1037/a0016765

Gotlib, I. H., & Joormann, J. (2010). Cognition and depression: Current status and future directions. *Annual Review of Clinical Psychology*, *6*(1), 285–312. doi:10.1146/annurev.clinpsy.121208.131305

Gross, J. J. (2014). Emotion regulation: Conceptual and empirical foundations. In J. J. Gross (Ed.), *Handbook of emotion regulation* (2nd., pp. 3–20). New York, NY: Guilford Press. doi:10.1080/00140130600971135

Hajcak, G., & Olvet, D. M. (2008). The persistence of attention to emotion: Brain potentials during and after picture presentation. *Emotion*, *8*(2), 250–255. doi:10.1037/1528-3542.8.2.250

Hajcak, G., Weinberg, A., MacNamara, A., & Foti, D. (2012). ERPs and the Study of Emotion. In S. J. Luck & E. S. Kappenman (Eds.), *The oxford handbook of event-related potential components*. New York, NY: Oxford University Press. doi:10.1093/oxfordhb/9780195374148.013.0222

Hakamata, Y., Lissek, S., Bar-Haim, Y., Britton, J. C., Fox, N. A., Leibenluft, E., … Pine, D. S. (2010). Attention bias modification treatment: A meta-analysis toward the establishment of novel treatment for anxiety. *Biological Psychiatry*, *68*(11), 982–990. doi:10.1016/j.biopsych.2010.07.021

Hallion, L. S., & Ruscio, A. M. (2011). A meta-analysis of the effect of cognitive bias modification on anxiety and depression. *Psychological Bulletin*, *137*(6), 940–958. doi:10.1037/a0024355

Hermanns, J., Florin, I., Dietrich, M., Rieger, C., & Hahlweg, K. (1989). Maternal criticism, mother-child interaction, and bronchial asthma. *Journal of Psychosomatic Research*, *33*(4), 469–476. doi:10.1016/0022-3999(89)90008-1

Holmes, A., Nielsen, M. K., & Green, S. (2008). Effects of anxiety on the processing of fearful and happy faces: An event-related potential study. *Biological Psychology*, *77*(2), 159–173. doi:10.1016/j.biopsycho.2007.10.003

Hooley, J. M., & Parker, H. A. (2006). Measuring expressed emotion: An evaluation of the shortcuts. *Journal of Family Psychology*, *20*(3), 386–396. doi:10.1037/0893-3200.20.3.386

Johnson, A. L., Gibb, B. E., & McGeary, J. (2010). Reports of childhood physical abuse, 5-HTTLPR genotype, and women's attentional biases for angry faces. *Cognitive Therapy and Research*, *34*(4), 380–387. doi:10.1007/s10608-009-9269-3

Jung, T. P., Makeig, S., Westerfield, M., Townsend, J., Courchesne, E., & Sejnowski, T. J. (2001). Analysis and visualization of single-trial event-related potentials. *Human Brain Mapping*, *14*(3), 166–185. doi:10.1002/hbm.1050

Kovacs, M. (1981). Rating scales to assess depression in school-aged children. *Acta Paedopsychiatrica*, *46*(5–6), 305–315.

Kuckertz, J. M., & Amir, N. (2015). Attention bias modification for anxiety and phobias: Current status and future Directions. *Current Psychiatry Reports*, *17*, 2. doi:10.1007/s11920-014-0545-x

Kujawa, A., Hajcak, G., Danzig, A. P., Black, S. R., Bromet, E. J., Carlson, G. A., … Klein, D. N. (2016). Archival report neural reactivity to emotional stimuli prospectively predicts the impact of a natural disaster on psychiatric symptoms in children. *Biological Psychiatry*, *80*(5), 381–389. doi:10.1016/j.biopsych.2015.09.008

Kujawa, A., Klein, D. N., & Hajcak, G. (2012). Electrocortical reactivity to emotional images and faces in middle childhood to early adolescence. *Developmental Cognitive Neuroscience*, *2*(4), 458–467. doi:10.1016/j.dcn.2012.03.005

Kujawa, A., Macnamara, A., Fitzgerald, K. D., Monk, C. S., Phan, K. L., Brook, S., … Biology, C. (2016). Enhanced neural reactivity to threatening faces in anxious youth: Evidence from the event-related potentials. *Journal of Abnormal Child Psychology*, *43*(8), 1493–1501. doi:10.1007/s10802-015-0029-4.Enhanced

Lang, P. J., & Bradley, M. M. (2010). Emotion and the motivational brain. *Biological Psychology*, *84*, 437–450. doi:10.1016/j.biopsycho.2009.10.007

Little, R. J. A., & Rubin, D. B. (1987). *Statistical analysis with missing data*. New York, NY: John Wiley & Sons.

Lopez-Calderon, J., & Luck, S. J. (2014). ERPLAB: An open-source toolbox for the analysis of event-related potentials. *Frontiers in Human Neuroscience*, *8*(April), 213. doi:10.3389/fnhum.2014.00213

MacLeod, C., Mathews, A., & Tata, P. (1986). Attentional bias in emotional disorders. *Journal of Abnormal Psychology*, *95*(1), 15–20. doi:10.1037/0021-843X.95.1.15

MacNamara, A., & Hajcak, G. (2010). Distinct electrocortical and behavioral evidence for increased attention to threat in generalized anxiety disorder. *Depression and Anxiety*, *27*(3), 234–243. doi:10.1002/da.20679

Magaña, A. B., Goldstein, M. J., Karno, M., Miklowitz, D. J., Jenkins, J., & Falloon, I. R. H. (1986). A brief method for assessing expressed emotion in relatives of psychiatric patients. *Psychiatry Research*, *17*(3), 203–212. doi:10.1016/0165-1781(86)90049-1

March, J. S., Parker, J., Sullivan, K., Stallings, P., & Conners, C. (1997). The Multidimensional Anxiety Scale for Children (MASC): Factor structure, reliability, and validity. *Journal of the American Academy of Child and Adolescent Psychiatry*, *36*, 554–565. doi:10.1097/00004583-199704000-00019

McCarty, C. A., Lau, A. S., Valeri, S. M., & Weisz, J. R. (2004). Parent-child interactions in relation to critical and emotionally overinvolved expressed emotion (EE): Is EE a proxy for behavior? *Journal of Abnormal Child Psychology*, *32*(1), 83–93. doi:10.1023/B:JACP.0000007582.61879.6f

Peckham, A. D., McHugh, R. K., & Otto, M. W. (2010). A meta-analysis of the magnitude of biased attention in depression. *Depression and Anxiety*, *27*(12), 1135–1142. doi:10.1002/da.20755

Pine, D. S., Mogg, K., Bradley, B. P., Montgomery, L., Monk, C. S., McClure, E., … Kaufman, J. (2005). Attention bias to threat in maltreated children: Implications for vulnerability to stress-related psychopathology. *American Journal of Psychiatry*, *162*(2), 291–296. doi:10.1176/appi.ajp.162.2.291

Pischek-Simpson, L. K., Boschen, M. J., Neumann, D. L., & Waters, A. M. (2009). The development of an attentional bias for angry faces following Pavlovian fear conditioning. *Behaviour Research and Therapy*, *47*(4), 322–330. doi:10.1016/j.brat.2009.01.007

Pollak, S. D. (2003). Experience-dependent affective learning and risk for psychopathology in children. *Annals of the New York Academy of Sciences*, *1008*, 102–111. doi:10.1196/annals.1301.011

Pollak, S. D., & Kistler, D. J. (2002). Early experience is associated with the development of categorical representations for facial expressions of emotion. *Proceedings of the National Academy of Sciences*, *99*(13), 9072–9076. doi:10.1073/pnas.142165999

Pollak, S. D., & Tolley-Schell, S. A. (2003). Selective attention to facial emotion in physically abused children. *Journal of Abnormal Psychology*, *112*(3), 323–338. doi:10.1037/0021-843X.112.3.323

Price, R. B., Kuckertz, J. M., Siegle, G. J., Ladouceur, C. D., Silk, J. S., Ryan, N. D., … Amir, N. (2015). Empirical recommendations for improving the stability of the dot-probe task in clinical research. *Psychological Assessment*, *27*(2), 365–376. doi:10.1037/pas0000036

Rogosch, F. A., Cicchetti, D., & Toth, S. L. (2004). Expressed emotion in multiple subsystems of the families of toddlers with depressed mothers. *Development and Psychopathology*, *16*(3), 689–709. doi:10.1017/S0954579404004730

Rose, D. T., & Abramson, L. Y. (1992). Developmental predictors of depressive cognitive style: Research and theory. In D. Cicchetti & S. Toth (Eds.), *Rochester symposium of developmental psychopathology* (pp. 323–349). Rochester, NY: University of Rochester Press.

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods*, *7*(2), 147–177. doi:10.1037//1082-989X.7.2.147

Silk, J. S., Ziegler, M. L., Whalen, D. J., Dahl, R. E., Ryan, N. D., Dietz, L. J., … Williamson, D. E. (2009). Expressed emotion in mothers of currently depressed, remitted, high-risk, and low-risk youth: Links to child depression status and longitudinal course. *Journal of Clinical Child and Adolescent Psychology*, *38*(1), 36–47. doi:10.1080/15374410802575339

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics (5th ed.). Using multivariate statistics* (*5th* ed.). New York, NY: Pearson. doi:10.1037/022267

Van Bockstaele, B., Verschuere, B., Tibboel, H., De Houwer, J., Crombez, G., & Koster, E. H. W. (2014). A review of current evidence for the causal impact of attentional bias on fear and anxiety. *Psychological Bulletin*, *140*(3), 682–721. doi:10.1037/a0034834

Weinberg, A., & Hajcak, G. (2011). Electrocortical evidence for vigilance-avoidance in generalized anxiety disorder. *Psychophysiology*, *48*(6), 842–851. doi:10.1111/j.1469-8986.2010.01149.x

Weinberg, A., Venables, N. C., Proudfit, G. H., & Patrick, C. J. (2013). Heritability of the neural response to emotional pictures: Evidence from ERPs in an adult twin sample. *Social Cognitive and Affective Neuroscience*, *10*(3), 424–434. doi:10.1093/scan/nsu059

Williams, J. M. G., Watts, F. N., MacLeod, C. M., & Mathews, A. (1997). *Cognitive psychology and emotional disorders* (2nd ed.). Oxford, England: John Wiley & Sons.