



Failure to differentiate between threat-related and positive emotion cues in healthy adults with childhood interpersonal or adult trauma



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ABSTRACT

Enhanced threat-related processing is associated with both elevated anxiety and childhood exposure to trauma. Given the paucity of evidence regarding the effects of childhood and adult trauma exposure on subsequent psychophysiological processes in the absence of psychopathology, we investigated the relative impacts of childhood interpersonal and non-interpersonal trauma, as well as adult trauma exposure on neural processing of threat in healthy adults. We measured peak amplitudes of the N170 face-sensitive visual ERP component response to non-conscious and conscious Angry (threat) versus Happy (non-threat, positive) and Neutral (non-threat baseline) faces at temporo-occipital sites (right-T6; left-T5) in 489 psychiatrically asymptomatic adults (aged 18–70 years, 54% women, 94% right-handed). N170 peak amplitude differences between Angry vs Happy or Neutral faces were calculated and subjected to hierarchical multiple regression analysis, with trauma types (childhood interpersonal, childhood non-interpersonal and adult trauma) entered as predictors of interest. After controlling for sociodemographic and health factors, N170 peak amplitudes for non-conscious Angry vs Happy faces were inversely associated with childhood interpersonal trauma at T6 and adult trauma exposure at T5. Post-hoc repeated measures ANOVA indicated that unlike adults without trauma exposure, trauma-exposed adults failed to show significantly reduced N170 responses to Happy relative to Angry faces during non-conscious processing. This suggests that childhood interpersonal and adult trauma exposure are associated with a failure to differentiate between non-threat or positive and threat-related emotion cues. This is consistent with generalised hypervigilance seen in PTSD, and suggests trauma exposure is associated with a generalized heightened responsivity to non-conscious non-threat or positive as well as threat-related emotion cues in psychiatrically healthy adults.

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1. Background

Exposure to early life stress impacts upon the development of the neurobiological systems involved in stress and emotion regulation. Reported structural neural abnormalities associated with childhood trauma exposure include alterations in the corpus callosum (Kitayama et al., 2007) smaller hippocampal and prefrontal cortex volumes (Cohen et al., Frodl et al., 2010; Teicher et al., 2006), and larger amygdala (Lupien et al., 2011; Tottenham et al., 2010).

Functional neural abnormalities in similar regions have been reported in association with anxiety disorders, including adult post-traumatic stress disorder (PTSD). In particular, amygdala hyperactivation and hypoactivation in medial prefrontal cortex (mPFC) structures in response to threat-related stimuli have been widely reported in these clinical groups (Etkin and Wager, 2007; Shin and Liberzon, 2010). Abnormalities in amygdala structure (Lupien et al., 2009; Tottenham et al., 2010) and reduced functional connectivity between the amygdala and mPFC structures (Marusak et al., 2015) have also been implicated in disordered stress and emotion regulation. The convergence between neurobiological abnormalities associated with childhood trauma exposure and anxiety disorders in adults, and the well-established risks of adult

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psychopathology accompanying exposure to childhood trauma (Afifi et al., 2008; Kessler et al., 2010; Zlotnick et al., 2008), suggest that childhood trauma, particularly involving interpersonal trauma (Chu et al., 2013), may underlie abnormalities in threat-related neural processing and the regulation of associated emotions.

The processing of facial stimuli is crucial to adaptive social and emotional functioning. A preference for face-like patterns and the capacity to recognise the primary caregiver's face is evident within the first weeks of infancy (de Schonen and Mathivet, 1990; Johnson, 2005). By 7–12 months of age, infants display relatively greater visual evoked response potentials (ERPs) and a preferential allocation of attention to faces displaying threatening emotions (e.g. anger (Grossman, 2010; Grossman et al., 2007; Nelson and de Hann, 1996). The priority given to processing threat stimuli evident early in infancy reflects evolutionary pressures underpinning a reflexive capacity to avoid and survive potential harm (Vaish et al., 2008; Vuilleumier and Righart, 2011). Accordingly, potentiation of the bias towards processing threat-related stimuli could be expected among individuals exposed to childhood trauma in interpersonal contexts.

Studies demonstrating enhanced behavioural and psychophysiological responses to threat-related faces observed in maltreated children (for a review, see Cicchetti and Curtis, 2005) are consistent with potentiated bias towards processing of threat cues. Specifically, greater amplitudes for early visual and attentional ERPs (between 170 and 260 ms) for Angry relative to non-threat faces have been observed in 6-month to 2½-year old institutionalized vs non-institutionalized infants (Parker and Nelson, 2005), and in 1½–2½ year old maltreated compared to non-maltreated children (Cicchetti and Curtis, 2005; Curtis and Cichetti, 2013).

In older children and adults, enhanced amplitude of the early, face-specific N170 visual ERP component response to threat faces has been associated with the presence of anxiety. Among primary school-aged children with higher levels of anxiety, only those displaying greater N170 amplitude to Angry relative to Happy faces displayed sustained or increased anxiety levels two years later (O'Toole et al., 2013). Greater N170 amplitudes in response to Angry faces have also been observed in adults with high trait anxiety compared to those with low trait-anxiety (Bar-Haim et al., 2005; Kolassa and Miltner, 2006; Ofan et al., 2013). Japee et al. (2009) report similar associations between M170 (magnetoencephalographic equivalent of N170) response to threat-related faces and higher trait anxiety in adults. Furthermore this enhanced M170 response in adults with high trait anxiety is accompanied by better than normal ability to detect rapidly presented threat-related faces (Japee et al., 2009). These observations are consistent with the proposed evolutionary advantage afforded by a bias towards threat cues in emotion processing, but also highlight the burden this bias poses in increasing the vulnerability to anxiety disorders in the longer term.

However, there are also reports of reduced rather than enhanced early visual ERP amplitude responses to facial or threat-related stimuli among adults presenting with anxiety disorders and in particular PTSD, compared to controls (Adenauer et al., 2010; Felmingham et al., 2003; Wessa et al., 2005). Where enhanced early visual ERP responses to face stimuli has been reported in PTSD, this has been found specifically in high relative to low dissociation PTSD subjects (Klimova et al., 2013). These conflicting findings in the literature point to the need to take into account the heterogeneity in symptomatology between anxiety disorders, including PTSD subtypes (Lanius et al., 2010), when investigating psychophysiological responses to threat cues in trauma-exposed populations.

Given evidence for maltreatment exposure effects on emotion face processing in children (Cicchetti and Curtis, 2005; Curtis and

Cicchetti, 2013), a factor also needing to be considered in examining differential early ERP responses to threat stimuli in adults with anxiety disorders is the potential contribution of childhood trauma exposure to early neural responses to threat faces in the absence of clinical levels of anxiety symptoms. The increased incidence of anxiety disorders in adults with childhood trauma histories (Cougler et al., 2010) and evidence that childhood abuse is associated with higher levels of dissociative and posttraumatic symptoms (Hulette et al., 2014; Stein et al., 2013) further reiterates the importance of reducing the potential confound between anxiety symptomatology and childhood trauma when investigating the association between anxiety disorders and neural processing of threat cues.

We aimed to examine this question by assessing the impact of prior trauma exposure on the face-specific N170 response to Angry faces in a large sample of healthy, depression and anxiety disorder-free adults. Evaluating the effects of childhood trauma exposure in psychiatrically healthy adults allowed us not only to minimise the potential confounding effects of depressive or anxiety symptoms, but also of psychotropic medications on neural processing of emotional stimuli. In addition, we examined the relative impacts of childhood interpersonal trauma compared to other types of trauma on N170 responses to threat vs non-threat faces.

Given the robust evidence for the face-specificity of the N170 visual ERP and furthermore evidence for its sensitivity to facial emotion expressions (Hajcak et al., 2012), we focused on N170 peak amplitude as an index of early neural processing and response to face stimuli in our study. The N170 typically peaks around 140–180 ms over temporo-occipital regions. The reliability of N170 peak amplitude measures across time have been demonstrated (Cassidy et al., 2012), particularly when derived from 30 or more face stimuli presentations (Huffmeijer et al., 2014). In addition, several studies have demonstrated greater N170 component response to threat compared to non-threat faces in normal adults (Batty and Taylor, 2003; Blau et al., 2007; Calvo and Beltran, 2013; Rellecke et al., 2011). Although conflicting findings regarding the emotion sensitivity of the N170 have also been reported (Eimer and Holmes, 2007), these discrepancies appear to relate to methodological differences such as stimuli characteristics (Leppanen et al., 2007; Wronka and Walentowska, 2011) or EEG references utilised (Joyce and Rossion, 2005). Additional evidence of N170 sensitivity to facial emotion can also be drawn from evidence of differentially greater N170 amplitudes to threat relative to Happy or Neutral faces when participants are demonstrably unaware of their emotion content (Pegna et al., 2008, 2011; Smith, 2011; Williams et al., 2007). These findings reiterate not only the sensitivity of N170 responses to threat-related facial expressions, but also the automaticity of threat-biased processing of facial emotion.

Given the greater risk to psychological health posed by interpersonal types of childhood trauma (Chu et al., 2013) and prior evidence of enhanced neural response to threat faces in groups with either child maltreatment or elevated anxiety, we hypothesised that.

- i. Exposure to childhood interpersonal trauma would be differentially associated with greater N170 amplitudes for Angry vs Happy (non-threat, positive) or Neutral (non-threat, baseline) faces compared to childhood non-interpersonal or adult trauma.

In addition, given the automatic nature of neural response to facial threat cues (Pegna et al., 2011), we also expected that.

- ii. Greater N170 amplitude for Angry vs Happy faces would be evident during non-conscious conditions.

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