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Effects of acute social stress on emotion processing in children

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Summary The current study investigates the effect of a single episode of acute social stress on healthy children's processing of facial expressions of emotion. Healthy nine- and ten-year-old boys (N = 39) underwent either a standardized psychosocial laboratory stressor (the Trier Social Stress Test for Children) or a control condition without exposure to socio-evaluative stress. Immediately thereafter, they classified pictures of faces displaying ambiguous facial expressions. Boys who had undergone the stress procedure were more likely to categorize ambiguously angry-fearful faces as fearful (and simultaneously less likely to categorize them as angry) relative to boys who had undergone the control condition. We suggest (i) that decreased sensitivity to anger cues following a stressful experience may represent an adaptive coping mechanism in healthy children, and/or (ii) that a heightened sensitivity to fearful cues may indicate the influence of children's own emotional states on their interpretations of others' emotional states.

Individuals differ in their attention to, and interpretations of, others' emotions. For example, individuals with high trait anxiety show attentional biases toward angry faces (Bradley et al., 2000), and individuals with depression show heightened attention toward sad faces (Gotlib et al., 2004). Transitory affective states also seem to influence emotion processing, with bipolar patients showing heightened sensitivity to negative emotions when exhibiting depressed symptoms but not when exhibiting manic symptoms (Gray et al., 2006).

Exposure to adverse environments can bias children's responses to emotional expressions. Abused and neglected children are quicker to detect angry faces and more likely to interpret ambiguous emotional expressions as angry than

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children with no history of maltreatment (Pollak and Sinha, 2002; Pollak and Kistler, 2002). In an fMRI study, children raised in an environment of chronic family stress exhibited atypical neural responses to fearful and angry faces (Taylor et al., 2006).

One mechanism through which adverse environments might influence emotion processing is through the repeated activation of acute stress responses. Healthy adults show enhanced processing (larger N170 amplitudes) for angry faces during anticipation of social stress (Wieser et al., 2009). To our knowledge, however, direct effects of acute social stress on children's emotion processing have not yet been studied. To address this gap, we conducted a study to investigate effects of a single episode of acute social stress on healthy children's interpretations of ambiguous emotional expressions. We predicted that social stress would influence sensitivity to emotional cues associated with social threat (in particular, angry faces).

1. Methods

1.1. Participants

Healthy nine- and ten-year-old boys (20 stress condition, 19 control condition) were recruited via newspaper advertisements and local schools to participate in a study investigating "children's perceptions of faces." A prescreening telephone interview was conducted with parents to ensure that the children were not suffering from physical illnesses, had not been diagnosed with a mental disorder, were not using prescription medications, and had normal academic performance. Due to the potential confounding influence of female sex hormones on cortisol responses starting in puberty (Kirschbaum et al., 1992), only boys were included. The study was approved by the local Institutional Review Board.

1.2. Procedure

Each 2-h session was scheduled for the mid-afternoon to control for diurnal variations in cortisol secretion. Parents were asked to ensure that their child refrained from eating 1 h prior to the session. Upon arrival at the laboratory, written consent was obtained from the parent. The child was introduced to the experimenter through a brief play session and completed validated German versions of the Social Anxiety Scale for Children (SASC-R-D, Melfsen and Florin, 1997) and the Child Depression Inventory (DIKJ, Stiensmeier-Pelster et al., 2000). Parents completed the Child Behavior Checklist (CBCL, Arbeitsgruppe Deutsche Child Behavior Checklist, 1998).

The child was first familiarized with the emotion classification task (described below) and then randomly assigned to take part in either the Trier Social Stress Test for Children (TSST-C; Buske-Kirschbaum et al., 1997) or a specifically-designed control condition. The TSST-C is a standardized psychosocial laboratory stressor in which a child is prompted to complete a story and perform a mental arithmetic task in front of a video camera and a two-person committee (Buske-Kirschbaum et al., 1997). Like the adult version (Trier Social Stress Test, TSST; Kirschbaum et al., 1993), it combines elements of socio-evaluative stress and uncontrollability. It induces reliable psychological and physiological stress responses in children (Buske-Kirschbaum et al., 1997; Schmitz et al., 2011). In the control condition, children read a simple text aloud and counted backwards (i.e., 100, 99, 98, etc.) while standing alone in a room. Thus, the control condition contained all factors of the TSST-C (e.g., orthostasis, speech task, cognitive load, timing of events) except for the psychosocially stressful components.

Immediately following the stress/control condition, the child completed an emotion classification task modeled on Pollak and Kistler (2002). Black-and-white facial images of one woman and man were taken from the NimStim set (Tottenham et al., 2009). Following Pollak and Kistler (2002), four pairs of prototype (100%) emotions (happy-sad, happy-fearful, angry-fearful, and angry-sad) were digitally morphed with each other using Winmorph 3.01 (http://debugmode.com/winmorph) in increments of 10%. This procedure yielded sets of nine ambiguous emotional expressions along four continua. Faces depicting the original prototype emotional expressions (100% happy, sad, fearful, and angry) were used only during the familiarization phase. The child viewed the ambiguous emotion images for the first time in the test phase. Each image (visual angle $9^\circ \times 12^\circ$) appeared in the center of a 56 cm computer screen (resolution 1680×1050 pixels) at a viewing distance of 60 cm. Each face was accompanied by two emotion labels and remained on the screen until the child indicated via button press which of the two emotions the face's expression more closely resembled. Faces were shown in four blocks (order randomized) corresponding to the four emotion continua.

After the procedure, the parent and child were debriefed and thanked. Children received a 15 Euro gift certificate to a children's store, and parents received 10 Euro to reimburse travel costs.

1.3. Stress response measures

Saliva samples were collected at six time points (at −1, +10, +20, +30, +40 and +55 min relative to the onset of the stress/control procedure) using a commercially-available sampling device (Salivette; Sarstedt, Nuembrecht-Rommelsdorf, Germany) and were stored at −20 °C. For biochemical analyses of free cortisol concentration, saliva samples were thawed and spun at 3000 rpm for 10 min to obtain 0.5—1.0 ml clear saliva with low viscosity. Salivary cortisol concentrations were determined by a commercially available chemiluminescence immunoassay (CLIA; IBL Hamburg, Germany). Inter- and intrassay coefficients of variation were both under 8%.

Subjective stress ratings were collected at seven time points (at −15, −1, +5, +10, +20, +30, and +40 min relative to the onset of the stress/control procedure) and assessed how fearful and nervous the child felt using two 10-point scales ranging from "not at all" to "very much" (Schmitz et al., 2011).

1.4. Statistics

To test the effects of the stress manipulation, we conducted two-way analysis of variance (ANOVA) with repeated measures for cortisol and subjective stress (group [2 groups: stress versus control] by time [repeated factor: 6 for cortisol,