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Short communication

Maternal bonding in childhood moderates autonomic responses to distress stimuli in adult males

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HIGHLIGHTS

- Autonomic nervous system responses to vocal distress are moderated by quality of participant maternal bonding during childhood.
- Participants who reported optimal maternal bonding showed greater calming response to distressful stimuli.
- Participants who reported non-optimal maternal bonding showed a heightened distress response to distressful stimuli.

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ABSTRACT

Mother-child bonding influences the development of cognitive and social skills. In this study we investigate how maternal attachment, developed in early childhood, modulates physiological responses to social stimuli later in life. Our results suggest that the autonomic nervous system's responses to vocal distress are moderated by the quality of participants' maternal bonding. In particular, participants with optimal maternal bonding showed a greater calming response to distressful stimuli whereas participants with non-optimal maternal bonding showed a heightened distress response.

1. Introduction

Attachment theory, initially described by Bowlby [1], states that humans, similar to other animal species, have an innate, evolutionarily driven biological predisposition towards social interaction. Bowlby proposed that infants actively and instinctively seek and maintain caregivers' (usually the mother) proximity and care (see for example [2]). Caregivers too, are instinctively drawn to respond and interact with their offspring [3]. Therefore, the bonds formed through attachment function to maintain security [1,4] by attenuating psychological and physiological stress reactivity [5,6] and by potentially serving as psychobiological regulators of felt security [4]. The quality of attachment developed with caregivers is crucial because it influences both cognitive and socio-emotional development and later on, the development of adult personality. Studies have shown that high quality bonding with caregivers provides infants with an optimal relational experience that will help the child to better interact with his or her external social environment [1,4]. Early caregiving relationships influence physiological processes as well [7,8], e.g. by modulating brain sensitivity to stress and the body's capacity for managing stress-related metabolic demands [9]. These attachment-based physiological patterns of emotion regulation are thought to remain relatively stable over individuals' lifetimes, suggesting important links between adult attachment style and health related physiological processes [10]. However, there has been relatively little research looking at the normative psychobiological functions of the attachment system [11]. In this study we investigate how early attachment relationships modulate physiological responses to social stimuli. Our aim is to assess how participants, who had different interactional patterns with their parents during childhood, respond physiologically to vocal distress signals (i.e. human and animal distress vocalisations, namely cries) as adults. Specifically, we want to explore the subcortical responses mediated by the autonomic nervous system (ANS). The

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autonomic nervous system consists of two subsystems; (i) the parasympathetic system, which is active under resting-state or calm conditions and whose activation is manifested by a decrease in heart rate, (ii) the sympathetic nervous system, which is active in fight-or-flight arousal responses that prepare the organism to action and whose activation is manifested by an increase in heart rate and blood flow to skeletal muscles. Considering the special evolutionary salience of infant cries for women [12], we decided to test only men who were not parents. Our study is driven by two predictions: (P1) In response to distress stimuli there will be a greater calming response in participants who report better levels (higher quality) of parental bonding. (P2) Participants who report lower quality parental bonding will show an increased sympathetic response to distressful stimuli.

2. Methods

2.1. Participants

Forty-four non-parent male adults (*M* = 24.7, SD = 5.06) were recruited as participants through a University database of volunteers and by announcements posted on the University of Trento web site. All participants were Caucasian, with Italian citizenship and had similar socio-economic status (middle–high level). All participants had heterosexual preferences and had previously shared the same household with two biological parents, at least until the age of 18. No participants had a history of psychiatric disorders or drug abuse. Informed consent was obtained from all participants. The study was conducted in agreement with the ethical principles stated in the Helsinki declaration.

2.2. Procedure

The study was conducted in two parts: the first part involved the completion of an online survey about attachment style (the parental bonding instrument (PBI)) and the second part was an experimental procedure that consisted of listening to audio files of distress cues while physiological responses were recorded at the Affiliative Behaviour and Physiology Lab in the Department of Psychology and Cognitive Science, University of Trento. After participants were briefed about the study, they gave their informed consent and were given instructions about the experimental procedure.

The PBI [13] is a 50-item self-report questionnaire developed to measure the principal parental dimensions of care and control, and is used in this study as a measure of the quality of parental bonding. In this questionnaire participants rate the parenting behaviour they received from their parents during childhood. Demographic information such as age, gender, and education level was collected in addition to the PBI. The survey was created and disseminated using a web-based survey platform (maybe put which one? Survey monkey? Qualtrics?). Participants were required to answer each question on the survey, so there were no missing data for any participants. The PBI investigates individuals' attachment style toward their parents (we specifically used the mother form) by measuring two dimensions, (i) care (affection) and (ii) overprotection (level of parental control). While the concept of care seems universally valid, some studies have shown that there are cultural differences in the interpretation of the concept of overprotection. Indeed in some cultural groups, overprotection may be considered a positive value. For example, Raudino et al. [14] found that Italian mothers were more overprotective towards their offspring than English mothers. Therefore, it is likely that overprotection is normative in Italy, which is where our sample is taken from. Scores in these two dimensions are distributed as a continuum, which enabled us to identify four main groups in the population: high care and high overprotection, high care and low overprotection, low care and high overprotection, low care and low overprotection (see Fig. 1A). Participants were categorized in the four groups using the median splits.

2.3. Stimuli

The stimuli were thirty 15-s long audio clips of distressful vocalizations. There were ten audio clips of infant cries (average fundamental frequency f_0 = 410.27 Hz; f_0 max = 741.01; f_0 range = 667.84 Hz), adult woman cries (f_0 = 429.41 Hz; f_0 max = 742.10 Hz; f_0 range = 662.67 Hz) and animal cries, respectively (average f_0 = 406.07 Hz; $f_{0\,max}$ = 603.82 Hz; f_0 = 662.67 Hz). Each audio clip was presented following a 10-s block of silence. All audio clips were organised into three different randomised sequences, and presentation order of the three sequences was counterbalanced across participants. The stimuli sequences were created using the open source software Audacity. Although, cries were interspaced with silence, the entire experimental experience was designed to simulate a continuously distressing situation. The level of distressfulness was tested in a pilot study, where 10 male participants (not included in the final sample) were asked to listen to and provide a behaviour judgement on the distress level felt (on a 7-point Likert scale) while listening to five different experimental sequences where the ratio between each block of crying and silence was manipulated. Participants judged the ratio of 15 s of crying to 10 s of silence as the most distressful (other options included; 5:5, 10:5, 10:10, 15:15; crying/silence in seconds).

2.4. Physiological recording and measures. Heart rate variability (HRV)

As an index of parasympathetic activity, we measured participants' heart rate variability (HRV) using a pulse oximeter (CONTEC CMS60D) placed on participants' left forefinger. Pulse oximeter as a measure of HRV has been shown to be sufficiently accurate when subjects are at rest [15], as well as when they are in non-stationary conditions (i.e. during the tilt test [16]). The standard deviation of absolute differences between successive intervals (SDSD) was used as an index of heart rate variability in time [17,18].

2.5. Nose temperature (T)

As index of sympathetic activity we measured participants' peripheral surface body temperature on the tip of the nose using a resistance thermometer (Applent at 4524) placed on participants' nose skin [19,20].

3. Results

Prior to data analysis, univariate and multivariate distributions of heart rate values and temperature values were examined for normality (using the Shapiro–Wilk test), homogeneity of variance (using the Levene's test), outliers, and influential cases [21]. All variables were found to be normally distributed. An analysis of variance (ANOVA) was used to determine if there was any effect of stimulus type (infant cry, woman cry and animal cry) on HRV or nose temperature. No main effect of stimulus type emerged on HRV, or on nose temperature (respectively: $F(1,77) = .001$, ns; $F(1,77) = .001$, ns).

Fig. 1(C–D) shows mean and SEM for both measures. Two way ANOVAs were performed to assess the effect of PBI-parent score and type of stimuli on each physiological response throughout the entire experimental session. A significant effect of PBI-parent score on participants' heart rate variability ($F(3,77) = 5.3$, $p = .002$, $\eta^2 = .08$)