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The vulnerability to interpersonal stress in eating disorders: The role of insecure attachment in the emotional and cortisol responses to the trier social stress test

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ABSTRACT

Background: Vulnerability to interpersonal stress is an important risk factor for Eating Disorders (EDs). Adult insecure attachment involves different emotional, biological and behavioural strategies to cope with social stressors. However, although attachment has proved to play a pivotal role in EDs, no study has yet explored the effects of attachment on the emotional and hypothalamic-pituitary-adrenal (HPA) axis responses to a psychosocial stressor in EDs.

Methods: Fifty-two ED women (29 with anorexia nervosa, 23 with bulimia nervosa) underwent the Trier Social Stress Test (TSST). Their emotional response was measured by means of the State-Trait Anxiety Inventory state scale while saliva samples were collected to measure cortisol secretion.

Results: According to the Experience in Close Relationship questionnaire scores, 21 ED patients had high attachment anxiety and 31 low attachment anxiety, whilst 34 had high attachment avoidance and 18 low attachment avoidance. Patients with high attachment anxiety or avoidance displayed heightened TSST-induced cortisol secretion and anxiety feelings, in comparison to those with low insecure attachment scores. Anxiety perception was associated with cortisol recovery after the test exposure but not with the HPA axis reactivity in insecure attached patients.

Conclusions: The present findings corroborate the hypothesis that attachment modulates the biological and emotional reactivities to an acute social threat in ED patients. The role of these attachment-mediated changes in vulnerability to interpersonal stress in EDs needs to be clarified in future studies.

1. Introduction

Attachment theory provides a clinical framework for emotional, physiological and behavioral responses to stressful life events. According to literature studies (Mikulincer and Shaver, 2007), early interactions with caregivers influence self-esteem development, emotion regulation capacities and the ability to seek and perceive social support. They promote the development of *internal working models* about the self and the availability of others which persist as expectations in adult intimate relationships (Haydon et al., 2012). Indeed, when people feel distressed, according to their attachment orientation they think about or get close to someone who can provide comfort and support. As a result, adult attachment styles may be considered as models of expectations, attitudes and beliefs associated with emotion regulation strategies to deal with distress (Mikulincer and Shaver, 2007).

Developmental studies indicate that parent-child relationships may play a critical role in the development and tuning of endogenous stress response systems, especially the hypothalamic-pituitary-adrenal (HPA) axis (Hostinar et al., 2014). When threatened by a stressor, infants turn to caregivers and this interaction may reduce their stress response and promote a long-term calibration of the endogenous stress reactivity system, providing the bases for effective coping and emotion regulation. When this process fails, exposure to stressors may induce dysregulated HPA axis responses, in terms of heightened, blunted or prolonged cortisol secretion (Del Giudice et al., 2011). Accordingly, cross-sectional studies have provided the evidence of different cortisol responses to stressors in insecure attached children (Gunnar, 2017;

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Johnson et al., 2018) and adults (Pierrehumbert et al., 2009) in comparison to secure attached individuals. This has also been confirmed by longitudinal studies. In particular, institution-raised orphans exhibited a reduced cortisol response to a social stressor at age 12 years whereas institution-raised orphans who were provided with high quality of foster care in the first 2 years of life exhibited a normal cortisol response (McLaughlin et al., 2015). In a more recent study, Fearon et al. (2017) showed that insecure attachment and low maternal care in the first two years of life were associated with a deranged pattern of cortisol response to a psychosocial acute challenge at age 13 years. On the other hand, cognitive stress appraisal is an important predictor of cortisol response to stress exposure (Gaab et al., 2003) and attachment modulates cognitive processing of social information.

The influence of insecure attachment in the pathophysiology of Eating Disorders (EDs) has largely been proved. Review studies have highlighted the association between insecure attachment and unhealthy eating behaviors in the general population (Faber et al., 2018) and confirmed a higher prevalence of insecure attachment in ED patients compared to healthy adults (Zachrisson and Skarderud, 2010). Emotion dysregulation, reduced self-esteem and interpersonal difficulties (Tasca and Balfour, 2014) have been proposed as possible mediators of the association between insecure attachment and EDs.

Alterations in the HPA axis functioning have been widely reported in patients with anorexia nervosa (AN) and bulimia nervosa (BN), although they have been ascribed mainly to ED-induced malnutrition (Lo Sauro et al., 2008; Monteleone et al., 2016a). In particular, the cortisol response to a psychosocial challenge test has been reported to be either increased, normal or decreased in ED subjects (Monteleone et al., 2018a). On the other hand, when childhood trauma experiences were taken into account, significantly reduced basal or stimulated HPA axis activities have emerged in childhood trauma-exposed ED patients with respect to non trauma-exposed ones (Monteleone et al., 2018b, c), suggesting that early experiences affect the reactivity of the HPA axis in people with EDs. To the best of our knowledge, no study has so far explored the impact of attachment on biological and emotional responses to a psychosocial stressor in EDs, although it has recently been demonstrated that in EDs attachment affects the cortisol awakening response (CAR) (Monteleone et al., 2018d). Therefore, in the present study, we have aimed to investigate the HPA axis and the emotional reactivities (and their possible associations) to the Trier Social Stress Test (TSST) in ED patients according to their attachment characteristics. The TSST (Kirschbaum et al., 1993) is considered the gold standard for assessment of acute psychosocial stress in laboratory conditions (Allen et al., 2017). We hypothesized that insecure attachment was associated with both abnormal HPA axis functioning and heightened negative affective response. Moreover, taking into consideration that avoidant attached individuals tend to adopt an emotional suppression strategy, which has been associated with increased cortisol reactivity (Gross, 2002), we hypothesized that a discrepancy between emotional and physiological responses to a psychosocial stressor would occur in ED patients with high attachment avoidance.

2. Methods

2.1. Participants

Patients consecutively admitted to the outpatient facilities of our ED centers were screened for the study. Inclusion criteria were: a) female gender; b) age ≥ 18 yrs; c) current diagnosis of AN or BN according to DSM-5 criteria; d) absence of current comorbid diagnosis of anxiety and depressive disorders and of current or past post-traumatic stress disorder; e) absence of severe physical disorders; f) no history of endocrine disorders, psychoactive substance use or head trauma; g) no use of drugs in the past 2 months; h) no smoking cigarettes in the last 3 months; i) no use of contraceptive pills; j) willingness to cooperate in the experimental procedures and to sign a written informed consent. Diagnostic assessment was made by trained psychiatrists by using the Structured Clinical Interview for DSM-5 Disorders–Research Version (First, 2016). Fifty-two female patients were enrolled: 17 of them met the diagnosis of AN, 12 of atypical AN and 23 of BN. Moreover, among AN patients, 24 were of the restrictive subtype and 5 were of the binge-purging subtype.

The study was approved by the ethics committee of both Universities and was carried out in accordance with the Declaration of Helsinki for experiments involving humans. All the participants gave their written consent after being fully informed of the nature and procedures of the study.

2.2. Experimental procedure

2.2.1. Psychological assessment

All patients were tested before entering specific treatment programs. They filled in the Eating Disorder Inventory-2 (EDI-2) (Garner, 1991); the Experience in Close Relationship (ECR) Questionnaire (Fraley et al., 2000); the State-Trait Anxiety Inventory (STAI) (Spielberg et al., 1983); the Childhood Trauma Questionnaire (CTQ) (Bernstein et al., 2003).

The EDI-2 questionnaire (Garner, 1991) is a validated instrument that investigates ED psychopathology and symptoms.

The ECR questionnaire (Fraley et al., 2000) provides attachment measurement in the context of adult intimate relationships. Following Brennan et al., (1998), attachment measurement lay its foundation on two insecure dimensions, anxious and avoidant, which can be represented on a cartesian plane where quadrants represent categories or styles. Since there is no consensus about the categorical or dimensional nature of attachment phenomena (Ravitz et al. 2010), we chose to take in consideration the two main insecure attachment dimensions (anxiety and avoidance) and, according to ECR cut-off scores (Fraley et al., 2000), we grouped our participants, first, on the basis of their attachment anxiety (high vs low) and then on the basis of their attachment avoidance (high vs low). The ECR questionnaire is one of the most reliable instruments to measure adult attachment style (Ravitz et al., 2010). Since ED patients often report a lack of intimate relationships, we have specifically investigated the presence of at least one close friendship in the initial assessment in order to ensure the correct use of this questionnaire.

The CTQ (Bernstein et al., 2003) is a 28-item questionnaire widely used to assess childhood adversities. The CTQ asks respondents to report on childhood experience across five types of maltreatments: emotional neglect (EN), emotional abuse (EA), sexual abuse (SA), physical neglect (PN) and physical abuse (PA). Scoring of the CTQ produces 5 subscale scores for each subtype of maltreatment and a composite CTQ total score encompassing all five subscales scores.

2.2.2. TSST

The TSST was performed between 2.30 PM and 4.30 PM when the HPA axis functioning is relatively stable and at a low level, so changes induced by experimental challenges are clearly evident. Given the effects of female sex steroids on the response to TSST, menstruating patients were tested within 7 days from the starting of their menses in order to have a plasma estrogen milieu in menstruating AN and BN women as close as possible to that of non-menstruating AN women.

Participants were asked to abstain from food and drink (other than water) for 6 h before the experimental session. They were received in a first room where they had a 20 min rest. Then, an operator explained that they would be required to give a 5-min mock job interview to an unknown panel on personal suitability for a job, detailing their strengths and qualifications, followed by 5 min of a mental arithmetic task performed out loud. This task consisted of serially subtracting 13 from 2034, as quickly and accurately as possible, still in front of the panel. If the subject made a mistake, he was asked to start over from the beginning. The panel of evaluators (consisting of one man and one

woman maintaining a neutral evaluative facial expression) were presented as experts in the evaluation of nonverbal behavior and participants were told that their performance would have been videotaped for subsequent analysis of the interview and nonverbal behavior. At the end of this period, subjects had 10 min to prepare the tasks. After this, subjects were conducted in the TSST room and were told to start the presentation. At the end of the tasks, they were led in the first room where they had a 50 min rest, trying to relax through magazine readings.

Saliva sample were collected in Salivette tubes (Sarstedt; Rommelsdorft, Germany) at the end of the resting period (T =-20); immediately before starting the TSST (T = 0), at the end of the TSST (T = 10) and 10 (T = 20), 30 (T = 40) and 50 min (T = 60) after the end of the test. Saliva was separated by centrifugation and stored at −20 °C until assayed for cortisol levels.

Saliva cortisol concentrations were determined by an enzyme immunoassay method, using a commercially available ELISA kit (Biochem Immunosystem, Milan, Italy). Intra- and inter-assay coefficients of variation were less than 8% and 8.7%, respectively. As measures of the cortisol response to TSST, the cortisol area under the curve relative to the ground (AUCg) and the AUC with respect to the increase (AUCi) were also calculated (Fekedulegn et al., 2007). Moreover, as suggested by a previous study (Juster et al., 2012), the cortisol recovery percentage change score was computed by using a percent change formula [(T60 – T20/T20) × 100]. This score was based on the values of cortisol in saliva samples taken at the end of the test (T60) and 10 min after the TSST (T20), as this is the average peak time point of cortisol response according to a meta-analysis (Dickerson and Kemeny, 2004). This score provides a measure of the gradual decrement of cortisol during the recovery phase of the TSST.

2.2.3. Psychological assessment during the TSST

The STAI state scale (Spielberg et al., 1983) was used to assess the perceived emotional arousal immediately before (T = 0) the beginning of the TSST and immediately after its end (T = 10).

2.3. Statistical analysis

All analyses were performed using the SPSS version 25 (SPSS Inc, Chicago, IL). Independent sample *t* test was used to compare demographic, clinical and anthropometric variables between groups with high and low attachment anxiety or avoidance. Differences in saliva cortisol levels and anxiety scores between groups with low or high attachment anxiety or avoidance were tested by analyses of variance (ANOVA) and covariance with repeated measures followed by the post-hoc Tukey's test. Group differences in saliva cortisol AUCg, AUCi and cortisol recovery score were tested by independent sample *t* test. The intragroup association between cortisol secretion, assessed as AUCi, AUCg and cortisol recovery score, and emotional response to TSST, evaluated in term of STAI-S values, was assessed by means of Pearson's correlation test. Finally, to further assess the association between attachment dimensions and cortisol and/or emotional responses to TSST, we explored these relationships, taking into account the possible effect of malnutrition, by means of regression analyses in the whole ED sample and in each ED subgroup (AN, atypical AN, BN).

A value of $p < .05$ was set as significant.

3. Results

3.1. Clinical and demographic data

Eight patients refused to participate into the study.

According to ECR questionnaire cut-off scores (Fraley et al., 2000), 21 ED patients (8 with AN, 5 with atypical AN and 8 with BN) displayed high attachment anxiety and 31 (9 with AN, 7 with atypical AN and 15 with BN) low attachment anxiety, whilst 34 (12 with AN, 7 with atypical AN and 15 with BN) displayed high attachment avoidance and 18 low attachment avoidance.

Table 1
Clinical and demographic characteristics of ED patients according to their ECR attachment anxiety score. Data are expressed as mean ± standard deviation.

	ED Patients with High Attachment Anxiety (n = 21)	ED Patients with Low Attachment Anxiety (n = 31)	t	P
AGE, yrs	23.19 ± 5.43	27.13 ± 9.72	1.85	.071
BMI, kg/m^2	19.88 ± 2.89	19.39 ± 2.95	−.56	.579
Illness Duration, yrs	6.26 ± 5.56	8.85 ± 7.67	1.26	.216
EDI-2_IN	17.29 ± 8.05	10.40 ± 8.13	−2.99	.004
EDI-2_MF	11.00 ± 6.68	7.47 ± 5.12	−2.04	.049
EDI-2_SI	9.81 ± 4.91	6.63 ± 4.91	−2.37	.022
EDI-2_BD	18.62 ± 7.09	11,53 ± 8.27	−3.18	.003
EDI-2_P	9.90 ± 3.82	6.07 ± 5.23	−2.86	.006
EDI-2_ID	9.48 ± 4.39	6.13 ± 4.99	−2.47	.017
EDI-2_I	12.29 ± 6.92	7.27 ± 8.26	−2.28	.027
EDI-2_DT	16.43 ± 5.69	13.83 ± 6.86	−1.42	.161
EDI-2_BU	8.29 ± 6.29	5.23 ± 6.27	−1.71	.094
EDI-2_IA	17.48 ± 5.20	10.83 ± 9.35	−3.24	.002
EDI-2_ASC	8.71 ± 4.99	7.03 ± 5.85	−1.07	.289
CTQ_EA	9.33 ± 4.45	8.20 ± 4.01	−.95	.347
CTQ_EN	12.52 ± 5.90	12.53 ± 4.46	.007	.995
CTQ_PN	6.81 ± 2.06	6.30 ± 2.23	−.83	.412
CTQ_PA	6.43 ± 2.18	5.73 ± 1.48	-1.36	.181
CTQ_SA	6.71 ± 3.52	5.23 ± .82	−1.89	.072
CTQ_TOT	50.05 ± 16.10	46.77 ± 11.09	−.86	.393
Cortisol recover percentage	−17.34 ± 32.84	18.78 ± 92.59	1.71	.093

BMI = Body Mass Index; EDI-2: Eating Disorder Inventory-2, IN: Ineffectiveness, MF: Maturity Fear, SI: Social Insecurity, BD: Body Dissatisfaction, P: Perfectionism, ID: Interpersonal Distrust, I: Impulsivity, DT: Drive for Thinness, BU: Bulimia, IA: Interoceptive Awareness, ASC: Ascetism; CTQ: Childhood Trauma Questionnaire, EA: Emotional Abuse, EN: Emotional Neglect, PN: Physical Neglect, PA: Physical Abuse, SA: Sexual Abuse, TOT: total.

No significant difference emerged in the proportion of categorical diagnoses (AN, atypical AN and BN) between the high and low attachment anxiety groups ($\chi^2 = 0.623$; $p = 0.733$) as well as between the high and low attachment avoidance groups ($\chi^2 = 0.467$; $p = 0.792$). Therefore, given the lack of observed significant difference in the prevalence of each insecure attachment category (anxious and avoidant) between AN and BN, as already reported (Tasca and Balfour, 2014), we adopted the ED transdiagnostical perspective (Fairburn et al., 2003), which merges AN and BN people in a single ED sample and compared clinical and demographic characteristics of ED patients according to their attachment dimensions (Tables 1 and 2).

3.2. Cortisol response to the TSST

In a first analysis, cortisol responses to TSST of AN, atypical AN and BN patients with high and low attachment anxiety were compared by a 3-way ANOVA with repeated measures. The analysis showed no significant effect for diagnosis ($F_{2, 46} = 1.51$, $p = 0.2$), but significant effects for attachment ($F_{1, 46} = 4.17$, $p < 0.05$) and time ($F_{5,230} = 3.18$, $p < 0.009$), and a significant diagnosis x attachment x time interaction ($F_{10,230} = 2.41$, $p < 0.01$). Indeed, in all 3 diagnostic groups cortisol responses were higher in patients with high attachment anxiety than in those with low attachment anxiety with slightly significant differences in their time patterns. Similarly, a 3-way ANOVA with repeated measures performed on cortisol responses to TSST of AN, atypical AN and BN patients with high and low attachment avoidance revealed no significant effect for diagnosis ($F_{2, 46} = 1.05$, $p = 0.3$), but significant effect for attachment ($F_{1, 46} = 7.86$, $p < 0.008$) and a trend towards a significant effect for time ($F_{5,230} = 2.11$, $p = 0.06$). Indeed, in all 3 diagnostic groups cortisol responses were higher in patients

Table 2
Clinical and demographic characteristics of ED patients according to their ECR attachment avoidance score. Data are expressed as mean ± standard deviation.

	ED Patients with High Attachment Avoidance (n = 34)	ED Patients with Low Attachment Avoidance (n = 18)	t	P
AGE, yrs	25.30 ± 8.60	25.89 ± 8.22	.24	.814
BMI, kg/m^2	19.17 ± 2.43	20.36 ± 3.61	1.37	.176
Illness Duration, yrs	8.48 ± 7.67	6.33 ± 4.99	−.99	.329
EDI-2_IN	16.24 ± 8.39	7.24 ± 5.90	−4.43	.000
EDI-2_MF	9.56 ± 6.03	7.65 ± 5.96	−1.07	.289
EDI-2_SI	9.50 ± 4.77	4.82 ± 3.63	−3.55	.001
EDI-2_BD	16.29 ± 8.65	10.76 ± 7.07	−2.28	.027
EDI-2_P	8.82 ± 4.95	5.29 ± 4.45	−2.48	.017
EDI-2_ID	8.91 ± 4.76	4.71 ± 4.33	−3.06	.004
EDI-2_I	11.29 ± 8.20	5.41 ± 6.31	−2.59	.012
EDI-2_DT	17.12 ± 4.68	10.47 ± 7.37	−3.39	.003
EDI-2_BU	6.88 ± 6.13	5.71 ± 7.03	−.61	.541
EDI-2_IA	16.06 ± 7.92	8.59 ± 7.58	−3.22	.002
EDI-2_ASC	8.97 ± 5.66	5.24 ± 4.39	−2.38	.021
CTQ_EA	9.76 ± 4.54	6.47 ± 2.18	−3.49	.001
CTQ_EN	13.44 ± 5.52	10.71 ± 3.39	−2.18	.034
CTQ_PN	6.94 ± 2.44	5.65 ± 1.06	−2.64	.011
CTQ_PA	6.21 ± 2.04	5.65 ± 1.22	−1.04	.305
CTQ_SA	6.06 ± 2.72	5.41 ± 1.69	−.89	.375
CTQ_TOT	51.06 ± 14.48	42.24 ± 8.26	−2.76	.008
Cortisol recover percentage	9.80 ± 88.08	−6.39 ± 46.01	−.73	.471

BMI = Body Mass Index; EDI-2: Eating Disorder Inventory-2, IN: Ineffectiveness, MF: Maturity Fear, SI: Social Insecurity, BD: Body Dissatisfaction, P: Perfectionism, ID: Interpersonal Distrust, I: Impulsivity, DT: Drive for Thinness, BU: Bulimia, IA: Interoceptive Awareness, ASC: Ascetism; CTQ: Childhood Trauma Questionnaire, EA: Emotional Abuse, EN: Emotional Neglect, PN: Physical Neglect, PA: Physical Abuse, SA: Sexual Abuse, TOT: total.

with high attachment avoidance than in those with low attachment avoidance (data not shown).

Since diagnosis had no significant influence on the attachment-related differences in cortisol responses to TSST, according to the ED transdiagnostical perspective (Fairburn et al., 2003), AN, atypical AN and BN people were considered as a single ED sample and their cortisol responses to TSST were compared according to attachment characteristics by a 2-way ANOVA with repeated measures. In particular, in the comparison between the high vs low attachment anxiety ED groups, significant main effects emerged for group ($F_{1,50}$ = 4.90, p = 0.03) and for time ($F_{5,250}$ = 3.34, p = 0.006) but not for group x time interaction ($F_{5,250}$ = 0.63, p = 0.6), indicating that saliva cortisol levels significantly increased after the TSST and that significant differences between the groups occurred in the magnitude of the cortisol response. Indeed, compared to patients with low attachment anxiety, those with high attachment anxiety exhibited enhanced saliva cortisol levels at the end of the resting period (T = -20); immediately before starting the TSST (T = 0), at the end of the TSST (T = 10) and 10 (T = 20) min after the end of the test (Fig. 1). Cortisol AUCg (t = -1.563, p = 0.124) and AUCi (t = 0.13, p = 0.897) and the cortisol recovery percentage change (t = 1.712; p = 0.093) of patients with high attachment anxiety did not differ significantly from those of participants with low attachment anxiety (Fig. 1, right panel and Table 1).

In the comparison between ED groups with low and high attachment avoidance, significant main effects emerged for group ($F_{1,50}$ = 9.05, p = 0.004) and for time ($F_{5,250}$ = 2.29, p = 0.04) but not for group x time interaction ($F_{5,250}$ = 0.75, p = 0.5), indicating that saliva cortisol levels significantly increased after the TSST and that significant differences between the groups occurred in the magnitude of the cortisol response. Indeed, compared to patients with low attachment avoidance, those with high attachment avoidance exhibited significantly enhanced saliva cortisol levels at all time points of the TSST (Fig. 2). A significant group difference emerged in cortisol AUCg (t = -3.056; p = 0.004) but not in cortisol AUCi (t = -1.631; p = 0.109) nor in cortisol recovery percentage change (t = -0.727; p = 0.471) (Fig. 2, right panel and Table 1).

Since the two groups of patients with low and high attachment avoidance differed significantly in EN, EA, PN and TOT CTQ subitem scores, a two-way ANOVA with repeated measures with these variables as covariates was performed. This analysis showed that neither EN (p = 0.4), or EA (p = 0.7) or PN (p = 0.1) or TOT (p = 0.5) CTQ scores affected the significant difference of the cortisol response to TSST between the two groups.

3.3. Emotional response to the TSST

STAI-S scores were not available for 2 patients (2 with low anxious and with low avoidant attachment).

A 3-way ANOVA with repeated measures performed on emotional responses to TSST of AN, atypical AN and BN patients with high and low attachment anxiety exhibited no significant effect for diagnosis ($F_{2, 44}$ = 0.19, p = 0.8), but significant effects for attachment ($F_{1, 44}$ = 4.91, p < 0.03) and for time ($F_{1,44}$ = 50.85, p < 0.0001). Similarly, 3-way ANOVA with repeated measures performed on emotional responses to TSST of AN, atypical AN and BN patients with high and low attachment avoidance displayed no significant effect for diagnosis ($F_{2, 44}$ = 0.15, p = 0.8), but significant effects for attachment ($F_{1, 44}$ = 10.63, p < 0.003) and for time ($F_{1,44}$ = 44.93, p < 0.0001). Indeed, in all diagnostic groups, patients with high attachment anxiety or avoidance showed STAI-S scores significantly higher than patients with low attachment anxiety or avoidance both before and after the TSST (data not shown).

As for cortisol, since diagnosis did not affect emotional responses to TSST, AN, atypical AN and BN people were considered as a single ED sample and their emotional responses to TSST were compared according to attachment characteristics by 2-way ANOVA with repeated measures. In the comparison between high and low attachment anxiety ED patients, significant effects emerged for time ($F_{1,48}$ = 58.439; p < 0.001) and group ($F_{1,48}$ = 4.094; p = 0.049) but not for the group x time interaction ($F_{1,48}$ = 2.068; p = 0.157) (Fig. 3, right panel). This indicates that anxiety levels significantly increased after the TSST and that differences between the two study groups existed in the magnitude but not in the pattern of anxiety feelings. ED patients with high attachment anxiety exhibited STAI-S scores significantly higher than patients with low attachment anxiety both before (p < 0.01) and after (p < 0.01) the TSST.

When anxiety perception was compared between high and low attachment avoidance ED patients, two-way ANOVA with repeated measure yielded significant effects for time ($F_{1,48}$ = 48.802; p < 0.001) and group ($F_{1,48}$ = 9.885; p = 0.003) but no significant group x time interaction ($F_{1,48}$ = 0.106; p = 0.747) (Fig. 3, left panel), pointing to a significant increase in anxiety levels after the TSST with differences in the size between the groups but not in the timing. ED patients with high attachment avoidance exhibited STAI-S scores significantly higher than patients with low attachment avoidance both before (p < 0.01) and after (p < 0.01) the TSST.

When anxiety increase was evaluated as the difference between post and pre-TSST STAI-S scores (Delta STAI-S), no significant differences emerged in the comparison of the high vs low attachment anxiety groups (t = -1.438; p = 0.157) and of the high/low attachment avoidance groups (t = 0.284; p = 0.779).

3.4. Correlations between cortisol and emotional responses to the TSST

In the high attachment anxiety group, no significant correlations emerged between STAI-S or Delta STAI-S values and cortisol AUCi or

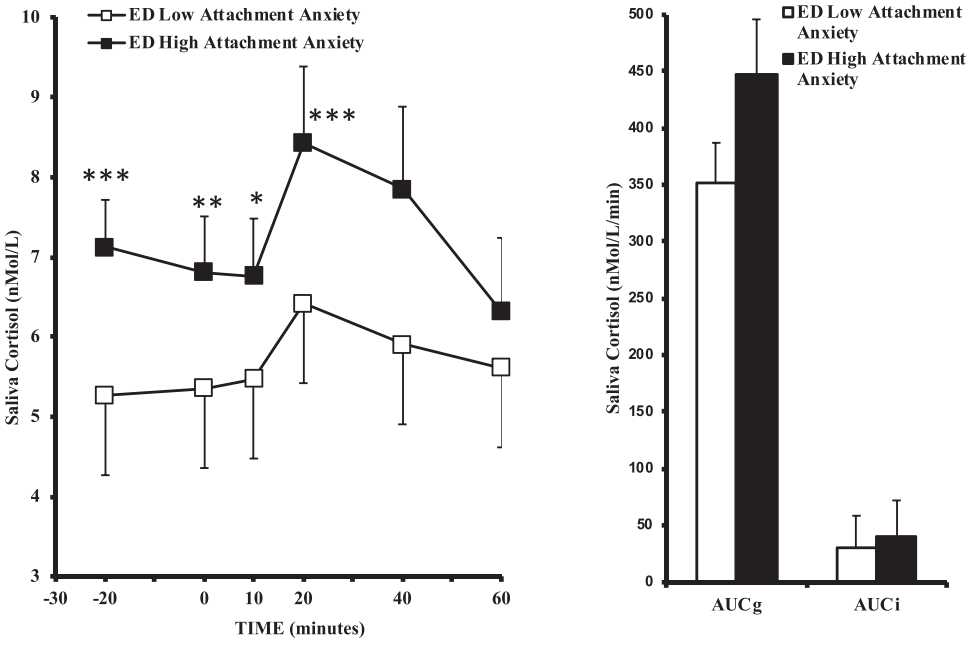

Fig. 1. Saliva cortisol production (left panel) and areas under the curve with respect to the ground (AUCg) and to the increase (AUCi) (right panel) in eating disorder (ED) women with high and low attachment anxiety undergoing the Trier Social Stress Test. Data are expressed as mean ± standard error. *p < 0.05, **p < 0.025, ***p < 0.005 (post-hoc Tukey's test).

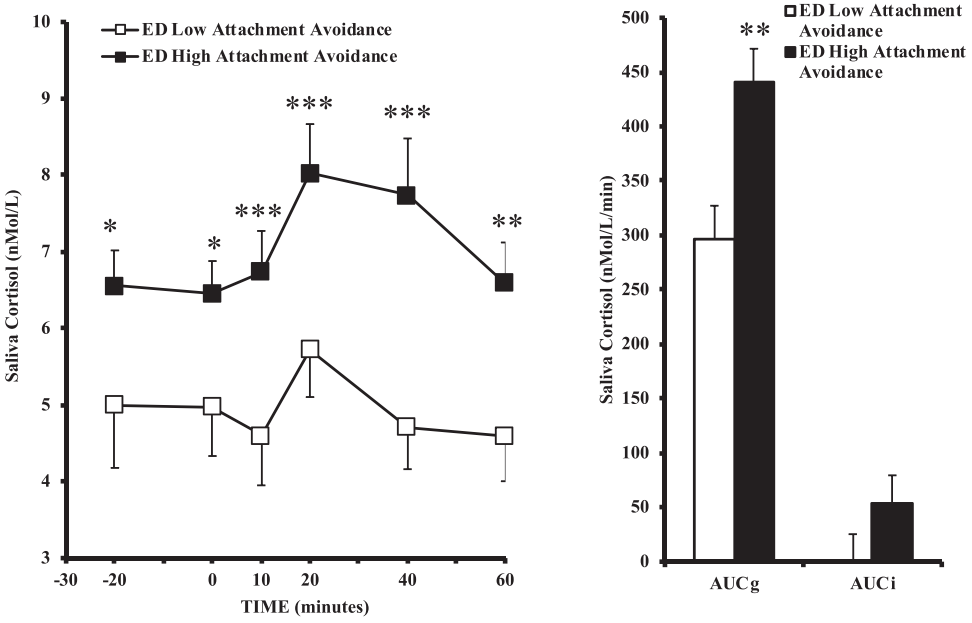

Fig. 2. Saliva cortisol production (left panel) and areas under the curve with respect to the ground (AUCg) and to the increase (AUCi) (right panel) in eating disorder (ED) women with high and low attachment avoidance undergoing the Trier Social Stress Test. Data are expressed as mean ± standard error. *p < 0.025, **p < 0.005, ***p < 0.001 (post-hoc Tukey's test).

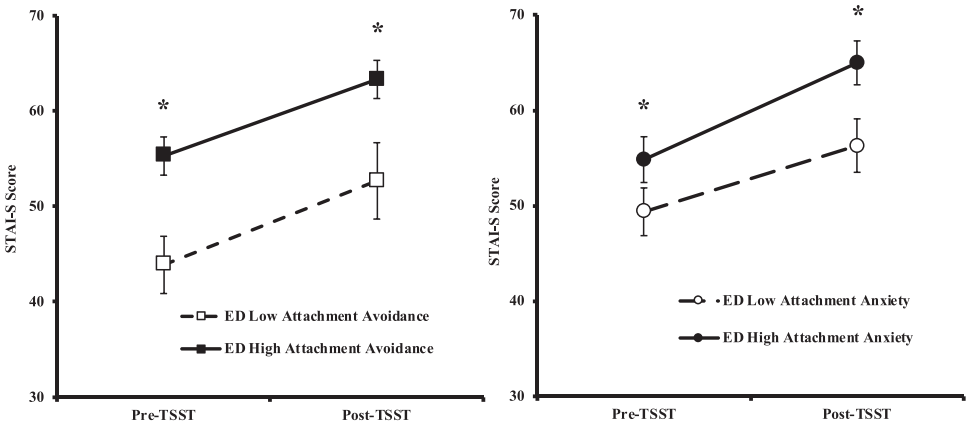

Fig. 3. State anxiety levels, as measured by the State-Trait Anxiety Inventory (STAI), in eating disorder (ED) women with high and low attachment anxiety (right panel) and ED women with high and low attachment avoidance (left panel) undergoing the Trier Social Stress Test. Data are expressed as mean ± standard error. *p < 0.01, (post-hoc Tukey's test).

AUCg scores. The cortisol recovery percentage scores were positively associated with STAI-S values both before (r = 0.539; p = 0.012) and after the TSST (r = 0.448; p = 0.042), suggesting that a higher emotional arousal before and after the social stress was associated with a slower cortisol return to baseline values.

In the high attachment avoidance group cortisol AUCi and AUCg values were not significantly associated with STAI-S scores whilst a negative significant association was found between cortisol recovery percentage scores and STAI-S values after the TSST (r = -0.365; p = 0.034) but not STAI-S scores before the TSST (r = -0.242; p = 0.169), which points to an association between higher TSST-induced anxiety perception and steeper cortisol recovery in patients with high attachment avoidance.

3.5. Regression analyses

Three regression models were built with the cortisol response to the TSST (expressed as AUCg or AUCi or cortisol recovery percentage) as the dependent variable and BMI, ECR attachment anxiety and avoidance scores as predictor variables. These models proved not to be statistically significant either in each diagnostic group or in the whole ED sample. The same models were applied to the emotional response to TSST, evaluated in terms of the post-TSST STAIS-score, as the dependent variable and attachment dimensions and BMI as predictors. This analysis proved to be statistically significant in the whole ED group (R^2 = 0.3; F = 6.41; p < 0.01) with all the included independent variables being significant predictors of post-stress anxiety (ECR anxiety: B = 0.19; p = 0.017; ECR avoidance: B = 0.189; p = 0.029; BMI: B = -1.27; p = 0.04). The same model was not statistically significant in either the AN (p = 0.072) or the atypical AN group whereas it revealed a statistical significance in the BN group (R^2 = 0.42; F = 4.57; p = 0.01). However, in the latter, none of the included variables independently predicted post-stress anxiety (ECR anxiety: B = 0.18; p = 0.088; ECR avoidance: B = 0.17; p = 0.129; BMI: B = -2.02; p = 0.07).

4. Discussion

Our study has investigated the endocrine and emotional responses to an acute social challenge in patients with EDs according to their adult attachment styles. Our first study hypothesis was confirmed, since ED patients with either high attachment anxiety or avoidance displayed heightened TSST-induced cortisol production and anxiety feelings in comparison to patients with low attachment anxiety or avoidance. The same response patterns emerged when the hormonal and the emotional responses to TSST were investigated in the AN, atypical AN and BN patient groups, separately. However, because of the relatively low number of participants in each diagnostic group and since diagnosis was a variable not affecting the stress-induced cortisol and emotional responses, we merged all the patients into a single ED sample, according to the ED transdiagnostical perspective (Fairburn et al., 2003). Our second study hypothesis was only partially confirmed as, in ED patients with high attachment avoidance, higher TSST-induced anxiety feelings were seen to be associated with steeper cortisol recovery but not with a reduced cortisol increase (as expressed by the cortisol AUCi). Moreover, in ED patients with high attachment anxiety, higher pre- and post-TSST anxiety levels were associated with a slower cortisol recovery.

Literature studies in healthy subjects have largely proved that HPA axis activity is highly sensitive to social stimuli (Kirschbaum et al., 1995; Eisenberger et al., 2007) and to early life experiences (Raymond et al., 2018). However, while some studies have shown that avoidant but not anxious attachment predicted enhanced, stress-induced cortisol response (Powers et al., 2006) other researchers have found opposite results (Quirin et al., 2008) or no significant differences between secure and dismissive attachment styles (Kidd et al., 2011). Therefore, the direction of the relationship between attachment style and cortisol response to acute stressors remains unclear.

To the best of our knowledge, no study has so far investigated the effects of attachment on HPA axis reactivity to acute stressors in ED patients. A recent meta-analysis failed to identify differences between ED patients and healthy subjects in the cortisol response to an acute social challenge while heightened negative affect was found in ED individuals both before and after the stress exposure (Monteleone et al., 2018a). We previously demonstrated that childhood adverse experiences are associated with a blunted basal (Monteleone et al., 2018b, d) and stress-induced (Monteleone et al., 2018c) cortisol production in ED patients. In the present study we have found that ED patients with high attachment avoidance or anxiety had an enhanced cortisol response to a psychosocial stress test and that this response was not affected by differences in patients' early traumatic experiences. Therefore, those findings as well as the present results further corroborate the hypothesis that HPA axis activity is modulated by early experiences and suggest that childhood attachment experiences and trauma may exert different independent long-term biological effects in ED people. Finally, the regression analysis showed no significant associations between stress-induced cortisol response and patients' BMI, ECR anxiety and avoidance scores, which supports the idea that in ED patients the influence of attachment on HPA axis reactivity is not a linear phenomenon but a cut-off effect.

Our results of increased anxiety perception during an experimental social challenge in insecure attached patients are in line with attachment theory which posits that these individuals are characterized by a heightened perception of social stimuli as threatening (Dewitte et al., 2007), by difficulties in managing their emotional responses and by reduced ability to cope with interpersonal stressors (Mikulincer and Shaver, 2012). Therefore, the present findings confirm that attachment contributes to the modulation of emotional reactivity to an acute social threat in ED patients. Furthermore, it has recently been demonstrated that anxious attached healthy children exposed to the TSST reported an increase in body dissatisfaction, a key psychopathological aspect of EDs, only when the TSST led to a decrease in positive affect (Goossens et al., 2017). This finding seems to corroborate the importance of insecure attachment as a factor that may confer vulnerability to interpersonal evaluation stress, which in turn may promote ED psychopathology. Finally, the regression analysis showed that in our ED patients a positive relationship emerged between attachment anxiety and avoidance dimensions and stress-induced emotional response, and that the lower the patients' BMI the higher the post-stress anxiety levels. Therefore, unlike the endocrine response to TSST, the emotional one seems to be linearly associated with insecure attachment and BMI.

No significant correlation was found between TSST-induced anxiety perception and overall cortisol reactivity, measured as AUCg or AUCi, in ED groups with high attachment anxiety or avoidance, whereas anxiety levels before and/or immediately after the TSST predicted the slope of cortisol return to baseline values. It is interesting to note that opposite directions of these associations were found between ED patients with high attachment anxiety and those with high attachment avoidance, since a higher emotional arousal was associated with a slower cortisol recovery in the former group and a steeper cortisol reduction in the latter. A previous study conducted in healthy individuals undergoing TSST showed that cortisol levels recovered more steeply when higher anticipatory stress was experienced (Juster et al., 2012). Therefore, our findings seem to suggest that, unlike in healthy individuals, in ED patients with high attachment anxiety the heightened anticipatory stress appraisal and emotion expression, which characterize these patients (Mikulincer and Florian, 1998), may be associated with a slower return of cortisol to baseline levels. Since highly anxious individuals tend to perceive relationships as more stressful (Mikulincer and Florian, 1998), it seems likely that a repeated stress-induced activation of the HPA axis activity with a deranged and/or prolonged cortisol recovery may favour a long term down-regulation of

its activity, as observed in our previous study showing that ED patients with high attachment anxiety exhibited a lower CAR than those with low attachment anxiety (Monteleone et al., 2018d).

It is worth underlining that we measured adult attachment relationships. Although the ECR questionnaire is considered a reliable indicator of infant attachment experiences (Sibley and Liu, 2004), there is increasing evidence to suggest that attachment reflects the quality of current relations rather than a trait (Main and Weston, 1981; Baldwin et al., 1996). Therefore, because of the cross-sectional nature of our study, it is not possible to rule out that in our adult ED sample, attachment reflects the state ability to regulate emotions in adult interpersonal relationships and modulate the impact of contextual stressors on the stress response system, as recently suggested (Fearon et al., 2017). Indeed, not only early caregiving experiences but also later interactions with peers contribute to detrimental social outcomes (Hostinar et al., 2014) as well as to ED psychopathology (Cardi et al., 2018).

4.1. Strengths and limitations

The main limitation of our study is the cross-sectional nature of our design, which limits the possibility to draw definitive conclusions regarding the nature of the relationship between attachment and responses to social stress. Moreover, the lack of a control group of healthy women with both secure and insecure attachment does not allow us to disentangle the effect of attachment from those of the illness on the interpersonal stress response. In addition, although in AN, atypical AN and BN groups cortisol and emotional responses to TSST revealed the same response patterns as the whole ED group, the number of participants in each diagnostic group was too low to draw definite conclusions. Therefore, further studies with larger patient samples are necessary to confirm whether the present findings apply transversally to all 3 diagnostic categories.

A strength of our study is that, according to previous suggestions (Allen et al., 2017), a number of variables (such as age, gender, menstrual cycle, smoking cigarettes, hunger status) potentially affecting the cortisol response to the TSST were controlled in our sample. Furthermore, in our study sample, no ED patient reported current psychiatric comorbidities or the use of drugs in the past 2 months, variables that have been reported to affect the TSST response (Allen et al., 2017)

4.2. Conclusions

Campbell and Ehlert (2012) proposed a model in which the emotional and physiological responses to a social stress and their interaction depend on psychological traits and states (such as emotion regulation, appraisal processes and social desirability) and physiological dispositions (such as brain morphology, HPA axis and autonomous nervous system baseline functional characteristics). Our findings in ED individuals seem to corroborate this hypothesis, providing further evidence that the attachment system may be an ideal framework to include these variables. Indeed, attachment experiences seem to account for the variability of both affective/cognitive processes and biological variables (at least the HPA axis functioning) that take part in the response to an interpersonal stress. Therefore, besides further supporting previous findings on the association between insecure attachment and ED psychopathology, our study adds new details on the hypothesis that insecure attachment may modulate interpersonal stress vulnerability in ED patients at both biological and emotional levels. Future research is needed to thoroughly and directly assess the reported effect of attachment in the interpersonal stress response on ED psychopathology and behaviours either in experimental settings or using ecological assessment procedures.

4.3. Clinical implications

Oxytocin has been shown to be dysregulated in EDs (Monteleone et al., 2016b) and to mediate the association between childhood emotional neglect, attachment representations and social fear in healthy subjects (Müller et al., 2018). Moreover, its intranasal administration was able to attenuate HPA axis stress response and attentional bias in ED patients (Leppanen et al., 2017). Therefore, on the light of the importance that attachment seems to exert on social stress reactivity in EDs, the present findings suggest the need to assess the effects of oxytocin administration depending on the subject's attachment style.

In addition, psychotherapeutic interventions focusing on attachment processes, such as cognitive information processing and emotion regulation ability, could be also therapeutically helpful. In line with this, Cognitive-Interpersonal Psychotherapy (Schmidt et al., 2014) and Cognitive Bias Modification for Interpretation biases programmes (Turton et al., 2018) have been shown to be effective in ED treatment. The extent to which these interventions impact on or act through the modulation of the biological and emotional responses to social stressors in ED people remains to be determined.

Contributors

Dr. A.M. Monteleone, Prof. P. Monteleone and Prof. M. Maj designed the study, wrote the protocol, and wrote the manuscript; Dr. G. Patriciello, Dr. V. Ruzzi and Dr. F. Pellegrino performed the clinical tests; Dr. C. Del Giorno performed laboratory assays; Dr. A.M. Monteleone and Dr. G. Cascino did statistical analyses; all the authors contributed to and approved the final version of the manuscript.

Conflict of interest

The authors declare that they do not have any conflict of interest.

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References

Allen, A.P., Kennedy, P.J., Dockray, S., Cryan, J.F., Dinan, T.G., Clarke, G., 2017. The trier social stress test: principles and practice. Neurobiol. Stress 6, 113–126. https://doi.org/10.1016/J.YNSTR.2016.11.001.

Baldwin, M.W., Keelan, J.P.R., Fehr, B., Enns, V., Koh-Rangarajoo, E., 1996. Social-cognitive conceptualization of attachment working models: availability and accessibility effects. J. Pers. Soc. Psychol. 71, 94.

Bernstein, D.P., Stein, J.A., Newcomb, M.D., Walker, E., Pogge, D., Ahluvalia, T., Stokes, J., Handelsman, L., Medrano, M., Desmond, D., Zule, W., 2003. Development and validation of a brief screening version of the Childhood Trauma Questionnaire. Child Abuse Negl. 27, 169–190. https://doi.org/10.1016/S0145-2134(02)00541-0.

Brennan, K.A., Clark, C.L., Shaver, P.R., 1998. Self-report measurement of adult romantic attachment: an integrative overview. In: Simpson, J.A., Rholes, W.S. (Eds.), Attachment Theory and Close Relationships. The Guilford Press, New York, pp. 46–76.

Campbell, J., Ehlert, U., 2012. Acute psychosocial stress: Does the emotional stress response correspond with physiological responses? Psychoneuroendocrinology 37, 1111–1134. https://doi.org/10.1016/J.PSYNEUEN.2011.12.010.

Cardi, V., Mallorqui-Bague, N., Albano, G., Monteleone, A.M., Fernandez-Aranda, F., Treasure, J., 2018. Social difficulties as risk and maintaining factors in anorexia nervosa: a mixed-method investigation. Front. Psychiatry 9, 12. https://doi.org/10.3389/fpsyt.2018.00012.

Del Giudice, M., Ellis, B.J., Shirtcliff, E.A., 2011. The adaptive calibration model of stress responsivity. Neurosci. Biobehav. Rev. 35, 1562–1592. https://doi.org/10.1016/J.NEUBIOREV.2010.11.007.

Dewitte, M., Koster, E.H.W., De Houwer, J., Buysse, A., 2007. Attentive processing of threat and adult attachment: a dot-probe study. Behav. Res. Ther. 45, 1307–1317. https://doi.org/10.1016/J.BRAT.2006.11.004.

Dickerson, S.S., Kemeny, M.E., 2004. Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. Psychol. Bull. 130, 355–391.

Eisenberger, N.I., Taylor, S.E., Gable, S.L., Hilmert, C.J., Lieberman, M.D., 2007. Neural pathways link social support to attenuated neuroendocrine stress responses.

Neuroimage 35, 1601–1612. https://doi.org/10.1016/J.NEUROIMAGE.2007.01.038.
Faber, A., Dubé, L., Knäuper, B., 2018. Attachment and eating: a meta-analytic review of the relevance of attachment for unhealthy and healthy eating behaviors in the general population. Appetite 123, 410–438. https://doi.org/10.1016/J.APPET.2017.10.043.
Fairburn, C.G., Cooper, Z., Shafran, R., 2003. Cognitive behaviour therapy for eating disorders: a "transdiagnostic" theory and treatment. Behav. Res. Ther. 41, 509–528. https://doi.org/10.1016/S0005-7967(02)00088-8.
Fearon, R.M.P., Tomlinson, M., Kumsta, R., Skeen, S., Murray, L., Cooper, P.J., Morgan, B., 2017. Poverty, early care, and stress reactivity in adolescence: findings from a prospective, longitudinal study in South Africa. Dev. Psychopathol. 29, 449–464. https://doi.org/10.1017/S0954579417000104.
Fekedulegn, D.B., Andrew, M.E., Burchfiel, C.M., Violanti, J.M., Hartley, T.A., Charles, L.E., Miller, D.B., 2007. Area under the curve and other summary indicators of repeated waking cortisol measurements. Psychosom. Med. 69, 651–659. https://doi.org/10.1097/PSY.0b013e31814c405c.
First, M.B., 2016. User's Guide for the SCID-5-CV: Structured Clinical Interview for DSM-5 Disorders, Clinician Version. American Psychiatric Association.
Fraley, R.C., Waller, N.G., Brennan, K.A., 2000. An item response theory analysis of self-report measures of adult attachment. J. Pers. Soc. Psychol. 78, 350–365.
Gaab, J., Blättler, N., Menzi, T., Pabst, B., Stoyer, S., Ehlert, U., 2003. Randomized controlled evaluation of the effects of cognitive–behavioral stress management on cortisol responses to acute stress in healthy subjects. Psychoneuroendocrinology 28, 767–779. https://doi.org/10.1016/S0306-4530(02)00069-0.
Garner, D.M., 1991. Eating Disorder Inventory-2 Professional Manual. Psychological Assessment Resources, Odessa.
Goossens, L., Van Durme, K., Van Beveren, M.-L., Claes, L., 2017. Do changes in affect moderate the association between attachment anxiety and body dissatisfaction in children? An experimental study by means of the Trier Social Stress Test. Eat. Behav. 26, 83–88. https://doi.org/10.1016/J.EATBEH.2017.01.011.
Gross, J.J., 2002. Emotion regulation: affective, cognitive, and social consequences. Psychophysiology 39, S0048577201393198. https://doi.org/10.1017/S0048577201393198.
Gunnar, M.R., 2017. Social buffering of stress in development: a career perspective. Perspect. Psychol. Sci. 12, 355–373. https://doi.org/10.1177/1745691616680612.
Haydon, K.C., Collins, W.A., Salvatore, J.E., Simpson, J.A., Roisman, G.I., 2012. Shared and distinctive origins and correlates of adult attachment representations: the developmental organization of romantic functioning. Child Dev. 83, 1689–1702. https://doi.org/10.1111/j.1467-8624.2012.01801.x.
Hostinar, C.E., Sullivan, R.M., Gunnar, M.R., 2014. Psychobiological mechanisms underlying the social buffering of the hypothalamic-pituitary-adrenocortical axis: a review of animal models and human studies across development. Psychol. Bull. 140, 256–282. https://doi.org/10.1037/a0032671.
Johnson, A.B., Mliner, S.B., Depasquale, C.E., Troy, M., Gunnar, M.R., 2018. Attachment security buffers the HPA axis of toddlers growing up in poverty or near poverty: assessment during pediatric well-child exams with inoculations. Psychoneuroendocrinology 95, 120–127. https://doi.org/10.1016/J.PSYNEUEN.2018.05.030.
Juster, R.-P., Perna, A., Marin, M.-F., Sindi, S., Lupien, S.J., 2012. Timing is everything: anticipatory stress dynamics among cortisol and blood pressure reactivity and recovery in healthy adults. Stress 15, 569–577. https://doi.org/10.3109/10253890.2012.661494.
Kidd, T., Hamer, M., Steptoe, A., 2011. Examining the association between adult attachment style and cortisol responses to acute stress. Psychoneuroendocrinology 36, 771–779. https://doi.org/10.1016/J.PSYNEUEN.2010.10.014.
Kirschbaum, C., Pirke, K.M., Hellhammer, D.H., 1993. The' Trier Social Stress Test'–a tool for investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology 28, 76–81. https://doi.org/10.1159/000119004.
Kirschbaum, C., Klauer, T., Filipp, S.-H., Hellhammer, D.H., 1995. Sex-specific effects of social support on cortisol and subjective responses to acute psychological stress. Psychosom. Med. 57.
Leppanen, J., Cardi, V., Ng, K.W., Paloyelis, Y., Stein, D., Tchanturia, K., Treasure, J., 2017. The effects of intranasal oxytocin on smoothie intake, cortisol and attentional bias in anorexia nervosa. Psychoneuroendocrinology 79, 167–174. https://doi.org/10.1016/J.PSYNEUEN.2017.01.017.
Lo Sauro, C., Ravaldi, C., Cabras, P.L., Faravelli, C., Ricca, V., 2008. Stress, hypothalamic-pituitary-adrenal axis and eating disorders. Neuropsychobiology 57, 95–115. https://doi.org/10.1159/000138912.
Main, M., Weston, D.R., 1981. The quality of the toddler's relationship to mother and to father: related to conflict behavior and the readiness to establish new relationships. Child Dev. 52, 932. https://doi.org/10.2307/1129097.
McLaughlin, K.A., Sheridan, M.A., Tibu, F., Fox, N.A., Zeanah, C.H., Nelson, C.A., 2015. Causal effects of the early caregiving environment on development of stress response systems in children. Proc. Natl. Acad. Sci. U. S. A. 112, 5637–5642. https://doi.org/10.1073/pnas.1423363112.
Mikulincer, M., Florian, V., 1998. The relationship between adult attachment styles and emotional and cognitive reactions to stressful events. In: Simpson, J.A., Rholes, W.S. (Eds.), Attachment Theory and Close Relationships. The Guilford Press, New York, pp. 143–165.
Mikulincer, M., Shaver, P.R., 2007. Attachment in Adulthood: Structure, Dynamics, and Change. Guilford Press.
Mikulincer, M., Shaver, P.R., 2012. An attachment perspective on psychopathology. World Psychiatry 11, 11–15. https://doi.org/10.1016/j.wpsyc.2012.01.003.
Monteleone, A.M., Monteleone, P., Serino, I., Amodio, R., Monaco, F., Maj, M., 2016a. Underweight subjects with anorexia nervosa have an enhanced salivary cortisol response not seen in weight restored subjects with anorexia nervosa. Psychoneuroendocrinology 70, 118–121. https://doi.org/10.1016/J.PSYNEUEN.2016.05.004.
Monteleone, A.M., Scognamiglio, P., Volpe, U., Di Maso, V., Monteleone, P., 2016b. Investigation of Oxytocin Secretion in Anorexia Nervosa and Bulimia Nervosa: Relationships to Temperament Personality Dimensions. Eur. Eat. Disord. Rev. 24, 52–56. https://doi.org/10.1002/erv.2391.
Monteleone, A.M., Treasure, J., Kan, C., Cardi, V., 2018a. Reactivity to interpersonal stress in patients with eating disorders: a systematic review and meta-analysis of studies using an experimental paradigm. Neurosci. Biobehav. Rev. 87, 133–150. https://doi.org/10.1016/J.NEUBIOREV.2018.02.002.
Monteleone, A.M., Monteleone, P., Volpe, U., De Riso, F., Fico, G., Giugliano, R., Nigro, M., Maj, M., 2018b. Impaired cortisol awakening response in eating disorder women with childhood trauma exposure: evidence for a dose-dependent effect of the traumatic load. Psychol. Med. 48, 952–960. https://doi.org/10.1017/S0033291717002409.
Monteleone, A.M., Patriciello, G., Ruzzi, V., Cimino, M., Giorno, C.Del, Steardo, L., Monteleone, P., Maj, M., 2018c. Deranged emotional and cortisol responses to a psychosocial stressor in anorexia nervosa women with childhood trauma exposure: evidence for a "maltreated ecophenotype"? J. Psychiatr. Res. 104, 39–45. https://doi.org/10.1016/J.JPSYCHIRES.2018.06.013.
Monteleone, A.M., Patriciello, G., Ruzzi, V., Fico, G., Pellegrino, F., Castellini, G., Steardo, L., Monteleone, P., Maj, M., 2018d. Insecure attachment and hypothalamus-pituitary adrenal axis functioning in people with eating disorders. Psychosom. Med. 1. https://doi.org/10.1097/PSY.0000000000000629.
Müller, L.E., Bertsch, K., Bülau, K., Herpertz, S.C., Buchheim, A., 2018. Emotional neglect in childhood shapes social dysfunctioning in adults by influencing the oxytocin and the attachment system: results from a population-based study. Int. J. Psychophysiol. https://doi.org/10.1016/J.IJPSYCHO.2018.05.011.
Pierrehumbert, B., Torrisi, R., Glatz, N., Dimitrova, N., Heinrichs, M., Halfon, O., 2009. The influence of attachment on perceived stress and cortisol response to acute stress in women sexually abused in childhood or adolescence. Psychoneuroendocrinology 34, 924–938. https://doi.org/10.1016/J.PSYNEUEN.2009.01.006.
Powers, S.I., Pietromonaco, P.R., Gunlicks, M., Sayer, A., 2006. Dating couples' attachment styles and patterns of cortisol reactivity and recovery in response to a relationship conflict. J. Pers. Soc. Psychol. 90, 61.
Quirin, M., Pruessner, J.C., Kuhl, J., 2008. HPA system regulation and adult attachment anxiety: individual differences in reactive and awakening cortisol. Psychoneuroendocrinology 33, 581–590. https://doi.org/10.1016/J.PSYNEUEN.2008.01.013.
Ravitz, P., Maunder, R., Hunter, J., Sthankiya, B., Lancee, W., 2010. Adult attachment measures: a 25-year review. J. Psychosom. Res. 69, 419–432. https://doi.org/10.1016/J.JPSYCHORES.2009.08.006.
Raymond, C., Marin, M.-F., Majeur, D., Lupien, S., 2018. Early child adversity and psychopathology in adulthood: HPA axis and cognitive dysregulations as potential mechanisms. Prog. Neuro-Psychopharmacology Biol. Psychiatry 85, 152–160. https://doi.org/10.1016/J.PNPBP.2017.07.015.
Schmidt, U., Wade, T.D., Treasure, J., 2014. The maudsley model of anorexia nervosa treatment for adults (MANTRA): development, key features, and preliminary evidence. J. Cogn. Psychother. An Int. Q. 28, 48. https://doi.org/10.1891/0889-8391.28.1.48.
Sibley, C.G., Liu, J.H., 2004. Short-term temporal stability and factor structure of the revised experiences in close relationships (ECR-R) measure of adult attachment. Pers. Individ. Dif. 36, 969–975. https://doi.org/10.1016/S0191-8869(03)00165-X.
Spielberger, C.D., Gorsuch, R.L., Lushene, R., Vagg, P.R., Jacobs, G.A., 1983. Manual for the State-trait Anxiety Inventory. Consulting Psychologists Press, Palo Alto.
Tasca, G.A., Balfour, L., 2014. Attachment and eating disorders: a review of current research. Int. J. Eat. Disord. 47, 710–717. https://doi.org/10.1002/eat.22302.
Turton, R., Cardi, V., Treasure, J., Hirsch, C.R., 2018. Modifying a negative interpretation bias for ambiguous social scenarios that depict the risk of rejection in women with anorexia nervosa. J. Affect. Disord. 227, 705–712. https://doi.org/10.1016/j.jad.2017.11.089.
Zachrisson, H.D., Skårderud, F., 2010. Feelings of insecurity: review of attachment and eating disorders. Eur. Eat. Disord. Rev. 18, 97–106. https://doi.org/10.1002/erv.999.