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Salivary cortisol in response to acute social rejection and acceptance by peers

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Abstract

Past research indicates that social rejection predicts a wide range of psychological problems (e.g., depression), but laboratory studies examining self-reports of negative affect after social rejection have reported inconsistent results. Salivary cortisol was measured before and after a social rejection/acceptance manipulation for objective assessment of psychological distress subsequent to peer rejection. Rejected participants were predicted to show significantly greater salivary cortisol than accepted or control participants. The present research also examined several factors that may moderate the relationship between acute rejection and cortisol. As predicted, rejected participants exhibited significantly higher cortisol than accepted or control participants. Defensiveness moderated the relationship between rejection and cortisol; highly defensive rejected participants showed significantly lower cortisol than less defensive rejected participants after peer rejection. Results indicate that social rejection causes psychological distress, but highly defensive individuals appear to be less susceptible than less defensive individuals to increases in salivary cortisol after acute social rejection.

Keywords: Social rejection; Social acceptance; Ostracism; Salivary cortisol; Neuroendocrine; Defensiveness

Baumeister and Leary (1995) state that humans demonstrate a need to belong, evidenced by the "pervasive drive to form and maintain at least a minimum quantity of lasting, positive, and significant interpersonal relationships" (p. 497), and threats to fulfillment of this need should result in distress and pain (Baumeister and Leary, 1995). Indeed, a recent fMRI study showed that the areas of the brain activated during physical pain are also activated during social rejection (Eisenberger et al., 2003). In addition, several studies have indicated that exclusion or rejection by peers often predicts the development of depression (e.g., Bell-Dolan et al., 1995; Hock and Lutz, 2001; Nolan et al., 2003; Reinherz et al., 2000), but recent laboratory studies have not reliably demonstrated the experience of distress or negative affect after rejection (e.g., Baumeister et al., 2002; Bourgeois and Leary, 2001; Twenge et al., 2002, 2003). Therefore, the purpose of the present study was to objectively measure psychological distress by assessing salivary cortisol before and after a social rejection/acceptance manipulation.

Cortisol, a glucocorticoid hormone secreted by the adrenal gland (Lovallo and Thomas, 2000), is a strong correlate of psychological distress, especially when distress arises from a social-evaluative threat (Dickerson and Kemeny, 2004). In fact, several empirical studies report elevated salivary cortisol secretion in response to stressful events, distress, and negative affect, both acute and chronic (see Lovallo and Thomas, 2000; Erickson et al., 2003; Dickerson and Kemeny, 2004). Regarded as a "stress hormone," cortisol is elevated in individuals under duress to facilitate physiological and cognitive responses to stressful situations (Erickson et al., 2003) and to exert regulatory control over stress-related processes that might otherwise be harmful (Lovallo and Thomas, 2000). Cortisol freely crosses the blood–brain barrier (Lovallo and Thomas, 2000), and is involved within the brain in the regulation of various neuropeptide (e.g., neuropeptide Y) and neurotransmitter systems (e.g., serotonin, norepinephrine, dopamine, acetylcholine, glutamate). Via these interactions, it is believed that cortisol may influence the expression of emotional and social behaviors (e.g., attachment, temperament, mood; Erickson et al., 2003). By assessing salivary cortisol before and after social rejection/acceptance in the present study, we

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obtained an objective measure of distress that supplemented self-report measures of negative affect.

1. Possible moderators between social rejection and salivary cortisol

Previous research has indicated that several variables can moderate the relationship between social rejection and the affective, cognitive, and/or behavioral responses to rejection (see Kelly, 2001). Because it is believed that some of these same variables (e.g., gender, defensiveness, self-esteem, rejection sensitivity, depressive symptoms) could significantly moderate the relationship between peer rejection and cortisol, each factor was examined as a possible moderator.

As recent studies have not reliably found reports of distress or negative affect after rejection, suggesting the potential for a dissociation between self-reported affect and cortisol in the current study, we explored the possibility that defensiveness discouraged self-reporting of negative affect after rejection. Individuals who have a repressive/defensive coping style tend to deny the experience of distress in stressful situations (Jamner and Schwartz, 1986). They avoid negative affect and threatening cognitions, report using distraction strategies when confronted with negative stressors (Myers, 1998), and recall happy memories and generate pleasant thoughts more quickly (and also generate significantly more pleasant thoughts) than less defensive individuals after distressing and upsetting stimuli (Boden and Baumeister, 1997). In fact, these individuals appear to others to cope well with stress and negative emotion; appear to be well adjusted; report little anxiety, depression, or hostility; and do not report having many stressors (Jamner and Leigh, 1999).

Although these highly defensive (HD) individuals appear to be well adjusted and protected from mental illness, this unhealthy coping style results in a heightened physiological reaction to stressors (see Schwartz, 1990) and reduced immunocompetence (Esterling et al., 1993; Jamner and Leigh, 1999; Jamner et al., 1988). HD individuals also show higher basal cortisol (Brody et al., 2000; Brown et al., 1996; Frecska et al., 1988) and significantly greater increases in cortisol and adrenocorticotropic hormone (ACTH) after a social-evaluative stressor (al'Absi et al., 2000) than less defensive (LD) individuals. As a result, we expected HD individuals, although reporting less negative and more positive affect than LD individuals, to show higher cortisol after rejection than LD participants. This bias against self-report of distress could explain, in part, any dissociation between self-reported affect and salivary cortisol in HD individuals.

2. Salivary cortisol and social rejection

To date, two published studies have examined cortisol responses to social rejection. One study collected multiple salivary cortisol samples from preschool children nominated by their peers in the classroom as either "liked" or "disliked" (Gunnar et al., 2003). Boys and girls who received low numbers of "liked" nominations and high numbers of "disliked" nominations (socially rejected children) showed significantly higher salivary cortisol than children in the other groups. Another study (Stroud et al., 2002) measured salivary cortisol during and after a social exclusion manipulation. Adult participants interacted with two same-sex experimental confederates, and confederates slowly excluded participants from conversation verbally and nonverbally. Social exclusion led to significant increases in cortisol for women but not for men.

3. Goals of the current study and hypotheses

Although Stroud et al. (2002) compared salivary cortisol responses from participants exposed to either a social exclusion stressor or an achievement-oriented stressor, they did not include a social acceptance group or a control group in their study. In addition, the social rejection stressor employed by Stroud and her colleagues was a 30 min stressor during which participants were slowly excluded from conversation. Gunnar and her colleagues (2003) also examined salivary cortisol in relation to social rejection, but in young children based on peer ratings of sociometric status. The present study therefore aimed to extend the findings reported by Stroud et al. and Gunnar et al. by examining salivary cortisol in reaction to a more immediate social rejection stressor (i.e., "no one wants to work with you") in young adults, and by comparing responses from socially rejected participants to responses from socially accepted and control participants. Furthermore, this study sought to examine further whether gender moderates reactions to social rejection as previous studies have reported mixed results. While a handful of studies examining responses to social rejection have found that men and women do differ in their emotional, cognitive, and behavioral reactions to social rejection (Baldwin et al., 2003; Stroud et al., 2002; Williams and Sommer, 1997), several other studies investigating reactions to social rejection have not found any gender differences. Finally, we also wanted to examine the role other individual difference variables (e.g., defensiveness) may play in salivary cortisol reactions to rejection.

The first goal of the present study was to determine whether socially rejected individuals would exhibit significantly higher salivary cortisol in response to acute social rejection than accepted or control individuals. As salivary cortisol is strongly associated with measures of psychological distress, this study investigated whether rejection causes elevations in cortisol secretion. A radioimmunoassay technique was used to measure cortisol in rejected, accepted, and control participants exposed to a social rejection/acceptance manipulation. It was hypothesized that rejected participants would show higher cortisol secretion than accepted or control participants. As cortisol typically peaks approximately 20–30 min after the onset of a stressor, with maximal cortisol concentrations emerging 10–30 min after stress cessation (Kirschbaum and Hellhammer, 2000), we expected cortisol to peak approximately 30 min after the rejection/acceptance manipulation for those in the rejected condition.

The second goal was to determine whether individual differences moderate the relationship between social rejection

and salivary cortisol. It was believed that gender, defensiveness, self-esteem, rejection sensitivity, and depressive symptoms could moderate the relationship between peer rejection and cortisol. Each factor was tested as a possible moderator.

4. Research design and method

4.1. Participants

Two hundred and fifty-nine participants (53% male, 47% female), ranging in age from 17 to 27 (M = 19.0, S.D. = 1.35), were recruited from a general psychology participant pool. Participants received course credit for taking part in the experiment.

4.2. Questionnaires

Participants completed several questionnaires, including a demographics questionnaire, the Beck Depression Inventory (BDI; Beck et al., 1988), the Marlowe–Crowne Social Desirability Scale (MCSDS; Crowne and Marlowe, 1964[1]), the Taylor Manifest Anxiety Scale (TMAS; Taylor, 1953), the Rosenberg Self-Esteem Scale (Rosenberg, 1979), and the Rejection Sensitivity Questionnaire (Downey and Feldman, 1996). Additionally, participants completed the Leary Mood Measure (LMM; Buckley et al., 2004) to assess affect when salivary cortisol samples were collected. The LMM measures positive and negative affect using 20 mood descriptors on a 1–7 Likert-type scale (1 = not at all, 7 = extremely).

4.3. Experimental design and procedures

In the first session, participants completed personality questionnaires while listening to classical music. The purpose of session 1 was to collect background information from participants and to familiarize participants with the laboratory setting to reduce anxiety during session 2. At the conclusion of session 1, participants were given a list of instructions to follow prior to arriving for session 2. Participants were asked to refrain from consuming alcohol or caffeine, and from engaging in strenuous physical activity or exercise, for 24 h; to refrain from eating or drinking anything (except water) for 2 h; and to refrain from using any products containing tobacco or nicotine for at least 1 h prior to the scheduled session as cortisol is elevated subsequent to each of these activities (Kirschbaum and Hellhammer, 1989, 1994). Participants who were pregnant or taking prednisone (a prescription steroid medication) were not allowed to participate as both can elevate basal cortisol concentrations (Kirschbaum and Hellhammer, 2000).

Participants arrived at the laboratory for session 2 in groups of four to six 1 week after participating in session 1. To maximize the likelihood that observed cortisol elevations were task dependent, all experimental sessions were scheduled at 3:00 p.m. as there is less circadian variation in cortisol in the afternoon relative to the morning hours, when cortisol is typically higher and could potentially mask any rejection-induced rise in cortisol secretion (Erickson et al., 2003; Kirschbaum and Hellhammer, 2000).

Participants began the second session in separate rooms, and first completed a short health form to assess whether they followed the instructions given in session 1 (those who did not were excluded from session 2). Participants eligible for session 2 next engaged in a 20-min relaxation session (during which time they listened to soft classical music while reading a travel magazine, as used previously in similar studies; see Nejtek, 2002; Stroud et al., 2002). The relaxation session was designed to help participants rest and relax before the baseline saliva samples were collected, making it more likely that the baseline cortisol measurements collected from participants represented an accurate measure of typical basal salivary cortisol for each participant.

After the relaxation session, participants completed the LMM and provided the first saliva sample. Participants were then escorted to a larger room to engage in the social rejection/acceptance manipulation. This experimental manipulation is well-established within our laboratory and has been employed in numerous laboratory experiments (e.g., Twenge et al., 2001, 2003; Twenge and Campbell, 2003). Groups of 4–6 same-sex participants engaged in a 15-min group interaction session, and were given topics of discussion (e.g., "where are you from?," "what is your major?," "what are your hobbies?"; Sedikides et al., 1999) to get conversation started. At the conclusion of the interaction session, participants were told they would be paired up with one other person from the group to complete a task. They were informed that they could not work with anyone they knew prior to the experiment (e.g., friends, roommates; groups containing participants who knew each other were specifically instructed not to nominate each other), but that we wanted to form pairs of people who liked and respected each other. Group members were instructed to list the two group members they wanted to work with on a choice of partner form. They were also informed that they would be paired up with one of those

[1] Originally, the MCSDS was designed to measure socially desirable responding, which was defined by Crowne and Marlowe (1960) as "the need for subjects to obtain approval by responding in a culturally appropriate and acceptable manner" (p. 353). Weinberger et al. (1979), however, asserted that evidence from several studies showed that the MCSDS did not measure the construct it was thought to measure (the tendency to answer questions in a socially desirable direction), and also stated that Crowne and Marlowe (1964) found substantial evidence that the MCSDS measured defensiveness, affect inhibition, and protection of self-esteem. In their 1979 study, Weinberger and his colleagues used the MCSDS, along with the TMAS, as a measure of repressive/defensive coping, dividing participants into four distinct categories: true repressors (high defensive/low anxious), high defensive/high anxious (sometimes referred to as failed repressors; see Schwartz, 1990), low defensive/low anxious, and low defensive/high anxious. Since the publication of that study, several other researchers have employed the MCSDS and TMAS together as a measure of repressive/defensive coping. Schwartz (1990) states, however, that high scores on the MCSDS are open to two different interpretations; either high social desirability/impression management, or high repressive/defensive coping/self-deception. Although debate still exists as to whether the MCSDS measures social desirability or defensiveness, the MCSDS (along with the TMAS) was initially employed in the current study as a measurement of defensiveness, and therefore will be referred to as defensiveness throughout the paper.

two people. Participants were once again separated, and after they completed the form and the forms were collected, participants were randomly assigned to one of three conditions. Participants were told that they had to complete the next task alone either (1) because no one chose to work with them (rejected condition, $n = 80$), (2) because everyone chose to work with them and we could not have such a large group working together on the task (accepted condition, $n = 62$), or (3) because the experimenter accidentally assigned them to the wrong condition and they were supposed to complete the next task alone (control condition, $n = 97$).

After participants engaged in the group discussion, chose their potential partners, and received feedback consistent with group assignment, participants completed the LMM and provided the second saliva sample. Participants remained in the lab for 60 min after the social rejection/acceptance manipulation. During this time, they completed filler tasks designed not to interfere with cortisol (completing questionnaires, coloring). The third, fourth, fifth, and sixth salivary cortisol samples were collected 15, 30, 45, and 60 min after receiving feedback consistent with group assignment, respectively, and participants completed the LMM when each sample was collected.

Subsequent to providing the experimenter with the sixth saliva sample, participants completed a manipulation check questionnaire to ensure that the social rejection/acceptance manipulation was believable and that participants were not suspicious of the experimental manipulation. Any participants stating they did not believe the feedback given to them or believed the study was about rejection or acceptance were eliminated from further analyses. Participants were then debriefed. After debriefing, all participants completed a self-affirmation task (shown to increase positive mood and decrease negative mood after receiving negative self-threatening information; Koole et al., 1999) to ensure they were not upset when they left the laboratory.

4.4. Salivary cortisol collection and measurement

Participants were asked to deposit approximately 6 mL of saliva into plastic scintillation vials, and saliva samples were stored until assayed in a −20 °C research freezer. After thawing saliva samples at room temperature, samples were centrifuged at 3500 rpm for approximately 10 min to separate precipitant and supernatant. Two 500 μL aliquots of supernatant for each sample (i.e., duplicates) were pipetted into clean plastic vials for cortisol analysis. The RIA procedure was conducted using commercially available solid-phase RIA kits from Diagnostics Products Corporation (Coat-A-Count® Cortisol kit) to measure free cortisol (μg/dL) in the saliva samples. Intra-assay coefficients of variation were below 10%.

4.5. Statistical design and analysis

Responses from the manipulation check questionnaire were first assessed. Sixteen participants stated that they either did not believe the feedback given to them by the experimenter or believed the study was about reactions to rejection/acceptance. The data collected from these participants were eliminated from further analyses. All data were next examined for normality, outliers, and missing data. Analyses indicated that all variables were normally distributed, and no transformations were necessary. Outliers were defined as any score two interquartile ranges above/below the median for that variable, and were excluded from the sample. Participants with missing data were excluded from analyses ($n = 4$).

Next, zero-order correlations between salivary cortisol at the six assessment points, self-reported affect at the six assessment points, and all other variables across all participants were assessed. Data were next checked for independence as participants who interact with one another (as participants did during the 15-min group interaction) may generate data that are interdependent (see Kenny and La Voie, 1985). Kenny and La Voie (1985) suggest first calculating the intraclass correlation to determine if data are independent. The intraclass correlation was non-significant from zero (<.1), indicating that data met the ANOVA assumption of independence.

Three $2 \times 3 \times 6$ ANOVAs were conducted with Time (baseline, immediately after the social rejection/acceptance manipulation, and 15, 30, 45, and 60 min after receiving feedback consistent with group assignment) as the within subjects variable, Group (rejected, accepted, or control) and Gender as between subjects factors, and self-reported positive affect, negative affect, and salivary cortisol (μg/dL) as the dependent variables. For each ANOVA involving the within-subjects factor Time, the Greenhouse-Geisser adjusted values were used to determine statistical significance of the results to correct for violations of the homogeneity of treatment differences variances assumption (Maxwell and Delaney, 2004). Follow-up tests for significant main effects and interactions were conducted and Bonferroni corrected. In addition, effect sizes (ω^2; see Olejnik and Algina, 2000) were calculated for each significant effect.

General Linear Model (GLM) analyses were next conducted to determine whether current depressive symptoms, defensiveness, self-esteem, and rejection sensitivity significantly moderated the relationship between rejection and salivary cortisol. First, each variable was centered at the mean for that variable (Aiken and West, 1991). The experimental Group variable was then dummy coded, and interaction terms were created between the dummy coded Group variable and all centered continuous predictor variables (Aiken and West, 1991). These variables and the interaction terms were then entered as covariates into GLM, with Time as a repeated measures factor, and positive affect, negative affect, and salivary cortisol as dependent variables.

5. Results

5.1. Zero-order correlations

No significant correlations were found between self-reported affect and salivary cortisol at any of the six assessments. Significant negative correlations were found

Table 1
Correlations between defensiveness scores (from the MCSDS) and salivary cortisol (μg/dL) 20 min before (baseline), immediately after (0 min), and 15, 30, 45, and 60 min after the social rejection/acceptance manipulation for participants in the rejected, accepted, and control groups

	Cortisol −20 m	Cortisol 0 m	Cortisol +15 m	Cortisol +30 m	Cortisol +45 m	Cortisol +60 m
Rejected	−.18	−.39**	−.26*	−.32*	−.38**	−.33**
Accepted	−.04	−.02	−.15	−.10	−.03	−.03
Control	−.07	−.03	−.09	−.14	−.13	−.10

* $p < .05$.
** $p < .01$.

between defensiveness and cortisol at the five assessments after the rejection/acceptance manipulation. Further examination revealed that the correlations between defensiveness and cortisol were significant only for rejected participants, indicating that those who had higher defensiveness scores exhibited lower cortisol concentrations after rejection (Table 1). There were no other significant correlations between cortisol and any of the other variables measured.

5.2. Self-reported affect

Two 2 × 3 × 6 ANOVAs were conducted to assess whether female and male rejected, accepted, and control participants reported significant differences in positive and negative affect over the six assessment points. Neither the Time × Group × Gender interaction nor the Time × Gender interaction was significant for positive or negative affect. The Time × Group interaction was significant, however, for negative affect, $F(7.00, 717.93) = 3.56$, $p < .01$, $\omega^2 = .056$, and marginally significant for positive affect, $F(7.74, 793.32) = 1.90$, $p = .06$, $\omega^2 = .017$. Follow-up analyses indicated that rejected participants reported significantly more negative affect than accepted and control participants and significantly less positive affect than accepted participants immediately after (i.e., at 0 min) the rejection/acceptance manipulation ($p < .05$). There were no significant differences between groups in self-reported affect at any other assessment point. Follow-up tests also revealed a significant decrease in positive affect ($p < .05$) and a marginally significant increase in negative affect ($p = .06$) for rejected participants from baseline (pre-rejection measure) to immediately after rejection (Fig. 1).

Negative affect was then divided into anger, depressed mood, hurt feelings, and anxiety. A one-way MANOVA was conducted to examine whether rejected, accepted, and control participants reported significant differences in any of these measures immediately after rejection/acceptance. Results were significant for depressed mood, $F(2, 210) = 5.94$, $p < .01$, and for hurt feelings, $F(2, 210) = 7.06$, $p < .01$. Further analyses revealed that rejected participants reported significantly more depressed mood and hurt feelings than accepted and control participants ($p < .05$; Fig. 2).

5.3. Salivary cortisol

A 2 × 3 × 6 ANOVA was conducted to determine whether female and male rejected, accepted, and control participants exhibited significant differences in salivary cortisol secretion at the six assessment points. Neither the Time × Group × Gender interaction nor the Time × Gender interaction was significant. The Time × Group interaction, however, was significant, $F(5.00, 582.87) = 2.98$, $p = .01$, $\omega^2 = .056$, indicating that rejected participants exhibited significantly greater cortisol concentrations subsequent to rejection than accepted and control participants (Fig. 3). Follow-up tests indicated that cortisol 30 and 45 min after rejection/acceptance was significantly greater for rejected participants than for accepted and control participants ($p < .05$). Cortisol for rejected participants 30 and 45 min after the rejection/acceptance manipulation was not, however, significantly greater than baseline (−20 min) cortisol, $p > .10$. Salivary cortisol for

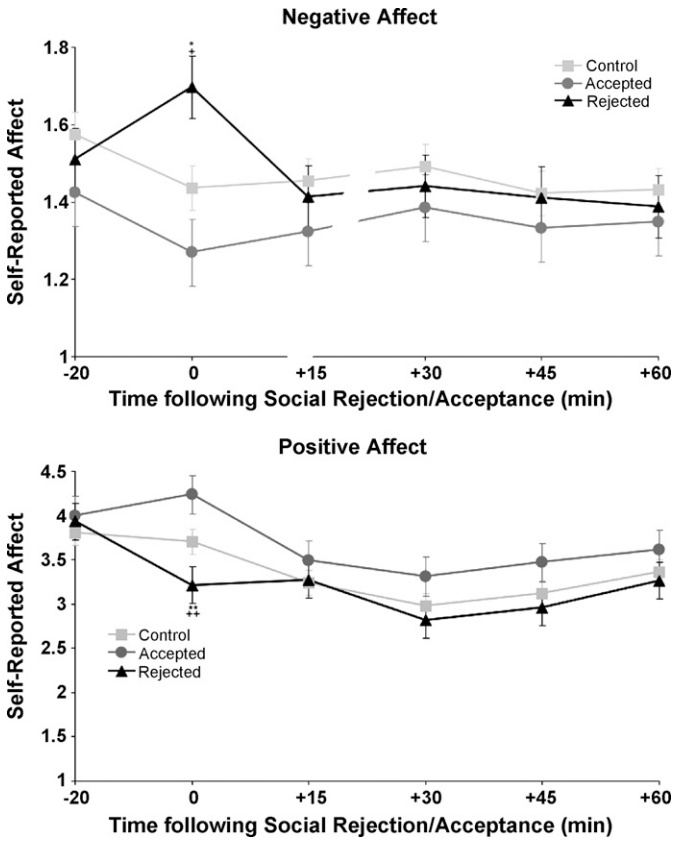

Fig. 1. Self-reported negative and positive affect 20 min before (baseline), immediately after (0 min), and 15, 30, 45, and 60 min after the social rejection/acceptance manipulation for participants in the rejected, accepted, and control groups. *Rejected group different than the accepted and control groups, $p < .05$. **Rejected group different than the accepted group, $p < .05$. $^{+}$Greater than the rejected group at −20 min, $p = .06$. $^{++}$Less than the rejected group at −20 min, $p < .05$.

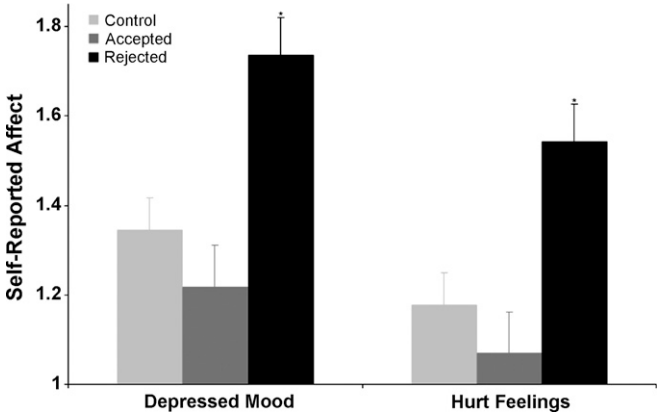

Fig. 2. Self-reported depressed mood and hurt feelings immediately after (0 min) the social rejection/acceptance manipulation for participants in the rejected, accepted, and control groups. *Rejected group greater than the accepted and control groups, $p < .05$.

control participants was significantly lower at 15, 30, 45, and 60 min after the rejection/acceptance manipulation than baseline cortisol ($p < .01$), and was significantly lower than baseline cortisol 30, 45, and 60 min after the manipulation for accepted participants ($p < .05$).

5.4. Moderator analyses

Finally, GLM analyses were conducted to assess whether defensiveness (along with anxiety), self-esteem, rejection sensitivity, and current depressive symptoms were significant moderators of the relationship between rejection and cortisol. There was a significant Time × Group × Defensiveness interaction on cortisol, Wilks' $\Lambda = .94$ ($F(5, 195) = 2.44$), $p < .05$, indicating that higher defensiveness scores for those in the rejected group corresponded with lower cortisol concentrations subsequent to peer rejection.

A median split was performed on the MCSDS ($Mdn = 16$) to dichotomize the variable in order to more adequately portray the significant three-way interaction in a graph and to conduct meaningful follow-up analyses. Participants who had a score of 16 and above on the MCSDS were categorized as HD; those who had a score below 16 on the MCSDS were categorized as LD. Although TMAS scores did not significantly affect the relationship between rejection and cortisol, as the MCSDS is typically combined with the TMAS to create a measure of repressive/defensiveness (see Weinberger et al., 1979), a median split was also performed on the TMAS ($Mdn = 7$), where participants who had a score of 7 and above on the TMAS were categorized as high anxious, and those who had a score below 7 were categorized as low anxious. When the dichotomized Defensiveness and Anxiety variables were entered into a 2 × 2 × 3 × 6 ANOVA, with Time as the within subjects variable, Group (rejected, accepted, or control), Defensiveness (high versus low), and Anxiety (high versus low) as between subjects factors, and salivary cortisol as the dependent variable, the Time × Group × Defensiveness interaction was significant, $F(7.57, 582.58) = 2.00$, $p < .05$, $\omega^2 = .051$ (Fig. 3). Neither the Time × Group × Defensiveness × Anxiety nor the Time - × Group × Anxiety interactions were significant.[2] A follow-up interaction contrast to the Time × Group × Defensiveness interaction from the repeated measures ANOVA indicated that cortisol was significantly higher for LD rejected participants than for HD rejected participants at all assessment points after rejection/acceptance ($p < .05$; Fig. 4). Interaction contrasts also showed that cortisol concentrations were significantly greater for

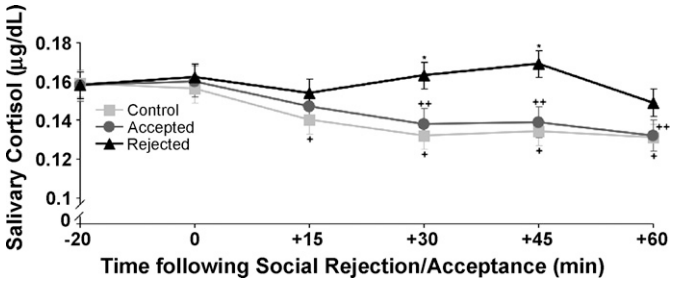

Fig. 3. Salivary cortisol concentrations (µg/dL) 20 min before, immediately after (0 min), and 15, 30, 45, and 60 min after the social rejection/acceptance manipulation for participants in the rejected, accepted, and control groups. *Rejected group greater than the accepted and control groups, $p < .05$. $^{+}$Less than the control group at −20 min, $p < .01$. $^{++}$Less than the accepted group at −20 min, $p < .05$.

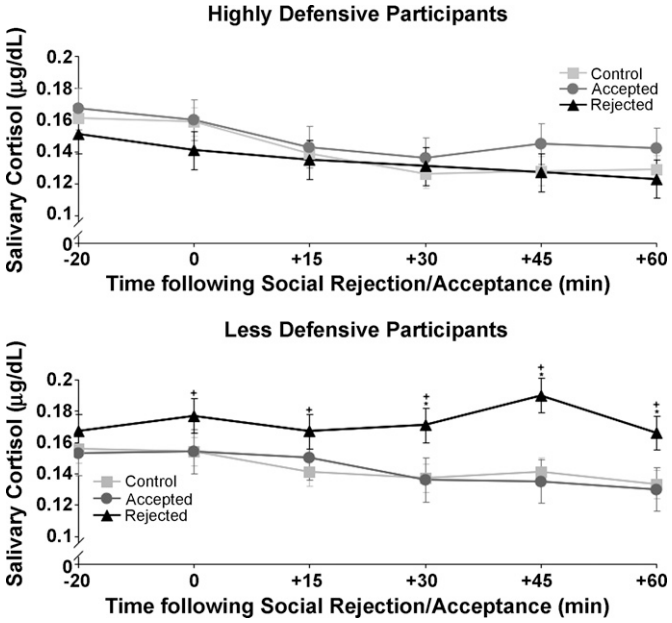

Fig. 4. Salivary cortisol concentrations (µg/dL) 20 min before, immediately after (0 min), and 15, 30, 45, and 60 min after the social rejection/acceptance manipulation for HD and LD participants in the rejected, accepted, and control groups. *Rejected group greater than the accepted and control groups, $p < .05$. $^{+}$LD rejected group greater than HD rejected group, $p < .05$.

[2] Participants were also divided into four categories based on their scores from the MCSDS and TMAS (see Weinberger et al., 1979): HD/LA (repressors), HD/HA, LD/LA, and LD/HA. This variable was then entered into a 2 × 4 × 6 ANOVA, with Time as the within subjects variable, experimental Group and MCSDS/TMAS group as between subjects factors, and salivary cortisol as the dependent variable. This three-way interaction was also non-significant.

LD participants in the rejected group relative to LD participants in the accepted and control groups 30, 45, and 60 min subsequent to the rejection/acceptance manipulation ($p < .05$). Cortisol 30, 45, and 60 min after rejection/acceptance was not, however, significantly greater than baseline cortisol for LD rejected participants. There were no significant differences in cortisol between HD and LD participants in the accepted and control groups. Furthermore, defensiveness scores did not predict self-reported positive or negative affect after the rejection/acceptance manipulation. No other continuous predictor variables significantly moderated the relationship between rejection and cortisol.

6. Discussion

Our first goal was to determine whether social rejection caused psychological distress, as evidenced through elevations in salivary cortisol. It was hypothesized that rejected participants would exhibit higher salivary cortisol than accepted or control participants after the social rejection/acceptance manipulation. Support for this hypothesis was obtained as cortisol was significantly higher for rejected participants subsequent to the rejection/acceptance manipulation than for accepted and control participants. Consistent with these findings, results also indicated that there was a significant difference in affect between groups, where rejected participants reported significantly more negative affect than accepted and control participants, and significantly less positive affect than accepted participants, immediately after rejection/acceptance.

These findings indicate that in addition to causing hurt feelings and depressed mood, peer rejection also causes psychological distress. Although cortisol did not increase significantly for rejected individuals, results indicated that cortisol concentrations remained elevated and did not decrease for rejected participants as they did for accepted and control participants. It should be noted that the significant decrease in cortisol observed for accepted and control participants over the time course of the experiment is consistent with the typical circadian rhythm for cortisol in the afternoon hours.[3] Previous research has shown a consistent decrease in cortisol in the afternoon and early evening hours (specifically between 3:00 p.m. and 6:00 p.m., the hours during which the current experiment was conducted) for healthy controls (e.g., Buchanan et al., 2004; Jerjes et al., 2005). Thus, maintenance in cortisol secretions for rejected participants, despite diurnal decline, is an indication of significant hypothalamic–pituitary–adrenal (HPA) axis activation. There was, however, no significant differences in cortisol between accepted and control participants. Although some research has shown a greater diurnal decline in cortisol for individuals reporting greater positive affect (e.g., Lai et al., 2005; Smyth et al., 1998), consistent with other findings (e.g., Moskowitz and Epel, 2006), we did not find that receiving positive social feedback was significantly correlated with cortisol secretion.

It therefore appears that telling participants that no one wanted to work with them was sufficient to keep cortisol elevated 45 min after the rejection/acceptance manipulation. Furthermore, cortisol was significantly greater for rejected participants 30 and 45 min subsequent to the rejection/acceptance manipulation than for accepted and control participants (who exhibited the typical diurnal curve in cortisol). It is suggested that a significant increase in cortisol might be observed after rejection or exclusion that occurs over a longer duration, such as when one is ignored and excluded from conversation over time (as was found by Stroud et al., 2002). Furthermore, although these results produced a moderate effect size, it is reasonable to expect that when people are rejected by those they already know (e.g., peer acquaintances, friends), this psychological distress may be even greater than when people are rejected by strangers (as they were in the current study). The results obtained from the current study are similar to findings from other studies examining salivary cortisol in response to rejection (Gunnar et al., 2003; Stroud et al., 2002; we did not, however, find a significant difference between men's and women's cortisol responses to social rejection as reported by Stroud et al.), and are also similar to results obtained in primate studies. For instance, Sapolsky et al. (1997) reported that socially subordinate and isolated wild baboons exhibited hypercortisolism, evidenced through basal hypersecretion of cortisol and glucocorticoid feedback resistance.

The importance of these results is that they provide a strong foundation for future research examining the link between social rejection and depression. Peer rejection has been shown to be a significant predictive factor of depression, and research conducted by Slavich et al. (submitted for publication) found that individuals who experienced rejection prior to the onset of depression developed depressive symptoms more quickly than individuals experiencing other types of stressors prior to the onset of depression. In addition, it is believed that chronic elevations in cortisol play a role in the development of depression. For instance, Johnson et al. (2006) found that repeated administration of corticosterone increased depressive-like symptoms in rats and disrupted normal HPA axis functioning.

Because of the role chronic elevations in cortisol appear to play in the development of depression (e.g., Johnson et al., 2006), it is hypothesized that elevations in cortisol after social rejection could potentially cause the development of depression and other psychological problems for those experiencing chronic peer rejection. If one is frequently and persistently rejected by his or her peers, this rejection may cause recurrent and chronic increases in cortisol, potentially triggering chronic hyperactivation of the HPA axis, and possibly causing the development of depressive symptoms. Future research will need to test this hypothesis.

The second goal of our study was to assess whether gender, defensiveness, self-esteem, rejection sensitivity, and current

[3] Although efforts were made to reduce anticipatory anxiety prior to the collection of baseline salivary cortisol samples, the possibility that participants still experienced anticipatory anxiety should be noted, which may have been reflected in baseline salivary cortisol concentrations. As a result, the decline in salivary cortisol exhibited by participants may not only reflect diurnal decline, but also a reduction in anticipatory anxiety.

depressive symptoms significantly affected the relationship between peer rejection and salivary cortisol. While neither gender nor rejection sensitivity, self-esteem, or depression moderated cortisol responses to rejection, defensiveness (as measured by the MCSDS) was a significant moderator of this relationship, where LD rejected participants showed significantly higher cortisol secretion than HD rejected participants subsequent to rejection/acceptance. Defensiveness did not, however, predict self-reported positive or negative affect after the rejection/acceptance manipulation.

Although HD individuals tend to report less negative affect and distress after a negative, stressful event, they typically exhibit a greater physiological response to stressors than LD individuals. It was therefore predicted that although HD participants would report less negative and more positive affect after rejection, they would show greater salivary cortisol after rejection than LD participants. Yet, results opposite to this prediction were obtained. Participants scoring high on the MCSDS exhibited significantly lower cortisol after being rejected than those scoring low on the MCSDS, and there was no difference between rejected HD and LD participants in self-reported positive or negative affect. Although these results are contrary to previous findings, they imply that HD individuals may be less susceptible to elevations in cortisol after acute peer rejection.

Perhaps defensiveness could be a protective factor following rejection by peers. Taylor et al. (2003) found that participants engaging in positive self-illusions exhibited lower baseline salivary cortisol and a lower cardiovascular response to stress than participants not engaging in positive illusions of the self, indicating that positive illusions may keep physiological and neuroendocrine responses to negative stressors low, leading to less activation of the HPA axis in response to stressful situations. Furthermore, Boden and Baumeister (1997) found that HD persons recall happy memories and generate pleasant thoughts more quickly (and also generate significantly more pleasant thoughts) than LD individuals following distressing and upsetting stimuli.

It is possible, however, that the non-response in cortisol to acute rejection seen in HD participants could potentially be harmful. During acute stress, cortisol is elevated in order to facilitate physiological and cognitive responses to stressful situations (Erickson et al., 2003) and to exert regulatory control over stress-related processes that might otherwise be harmful (Lovallo and Thomas, 2000). Thus, periodic elevations in cortisol may be adaptive in everyday life, and while prolonged increases in cortisol are potentially harmful, periodic rises in cortisol may be functional in the short term. The fact that HD individuals are not exhibiting elevated cortisol secretion subsequent to acute peer rejection could therefore be destructive over time, in that the effects of distress may be redirected to other systems, such as the sympathetic adrenal system. Furthermore, these results have implications for the development of social relations. If HD individuals are in denial about being socially rejected by their peers, they will likely not be motivated to engage in behaviors that can increase acceptance and decrease rejection by peers.

6.1. Limitations and future research

One limitation of our experiment was that HPA axis activity was assessed by only measuring salivary cortisol. It may be important to assess other indicators of HPA activity, such as corticotropin-releasing hormone (CRH), adrenocorticotropic hormone (ACTH), and proinflammatory cytokines, in order to fully understand the impact of social rejection on HPA activity (see Leonard, 2000; Raison and Miller, 2003).

Another limitation was how defensiveness was assessed. Although use of the MCSDS (along with the TMAS) was initially intended to measure defensiveness, much debate currently exists as to whether the MCSDS measures social desirability or defensiveness (see Schwartz, 1990; Holmes, 1990). The fact that scores on the MCSDS may be interpreted as indicative of either social desirability/impression management or defensiveness/self-deception may therefore make interpretation of the MCSDS as a moderating factor between rejection and cortisol difficult.

Much research remains to be conducted in order to fully understand the link between rejection and depression (as well as other psychological problems and disorders), and what role cortisol plays in this relationship. It is tentatively hypothesized that cortisol might mediate the relationship between peer rejection and depression for those who are frequently and persistently rejected by their peers. Future research should examine whether the chronic stress created by continuous peer rejection causes hyperactivation of the HPA axis, which in turn may bring about the development of depressive symptoms.

6.2. Conclusion

The results from this study indicated that social rejection by peers not only causes self-reported depressed mood and hurt feelings, but also causes salivary cortisol to remain elevated after rejection. Results also suggested that HD individuals are less susceptible to elevations in cortisol subsequent to acute peer rejection. Therefore, acute peer rejection appears to cause significant psychological distress, and perhaps elevations in cortisol after rejection might play a role in the development of psychological disorders, such as depression. Future research must examine whether cortisol mediates the relationship between rejection and depression, causing symptoms of depression for those frequently rejected by their peers. It is believed, however, that the results from this study have provided a foundation for future research to determine the link between rejection and depression, what protective factors and risk factors may exist in reaction to rejection, and how depression and other psychological problems may be prevented for those experiencing continuous peer rejection.

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