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Cortisol increases in response to brief social exchanges with opposite sex partners☆

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ABSTRACT

Researchers recently demonstrated that cortisol increases in response to mating-relevant social interactions. An important next step is investigating factors that explain individual differences in cortisol reactivity within these contexts. The current study examined demographic, situational, and individual difference predictors of cortisol reactivity following brief, non-face-to-face interactions with potential dating partners. College students made a video introducing themselves to another participant. During another appointment, they watched a short video of an opposite-sex confederate introducing himself/herself, and believed the other person was watching their video. Participants were told they would get to know the confederate more during a web-chat, which never took place. Participants received either rejection, acceptance, or no feedback from the confederate. Cortisol levels increased over baseline in all feedback conditions. Cortisol increases were particularly strong for participants who perceived the confederate as a more desirable dating partner, participants who were independently rated as a less desirable partner, and men.

1. Introduction

Choosing a good mate is an important endeavor with tangible consequences. Researchers have thus set out to understand the hormonal correlates of courtship and mate selection among humans. Prior research in this area has largely focused on testosterone, particularly among men (Archer, 2006; Gray et al., 2004; Roney, Lukaszewski, & Simmons, 2007). More recently, researchers started investigating the link between cortisol and mating-relevant interactions. Cortisol, a hormone released from the adrenal glands, helps mobilize resources by breaking down amino acids from fat and muscle tissue into glucose (see Lovallo and Thomas, 2000 for a review). The release of glucose provides energy for people to manage the demands of their current environment. Consistent with this logic, researchers have argued that energy mobilization (via the release of cortisol) may facilitate mating efforts (Roney et al., 2007).

Heterosexual men's cortisol levels rise in response to in-person interactions with women (Roney, Simmons, & Lukaszewski, 2010, Roney et al., 2007; van der Meij, Buunk, & Salvador, 2010). For instance, cortisol increased for men who engaged in a 15-min interaction with a woman, whereas it decreased for men who were alone in a room (Roney et al., 2007). Similarly, cortisol increased for men who interacted with a woman for 10–12 min, whereas it decreased for men who interacted with another man (Roney et al., 2010, 2007).

Cortisol also changes in mating-relevant contexts among heterosexual women. Specifically, cortisol increased over time for women who watched a 20-min video clip of an attractive man courting a woman, whereas it decreased or stayed the same for women in three non-mating control conditions (López, Hay, & Conklin, 2009).

An important next step is understanding the boundary conditions for mating-related cortisol increases. Specifically, researchers have not addressed whether cortisol increases are particularly strong for some people relative to others, and whether explicit social feedback from the interaction partner affects cortisol reactivity. The current study fills this gap in the literature in several ways. First, prior work has almost exclusively compared average cortisol levels for people interacting with an opposite sex versus same sex person. These studies provide consistent evidence that cortisol increases reliably in mating-relevant versus

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non-mating-relevant social interactions. However, little is known about variability among individuals *within* the mating context. There are a variety of individual differences and situational factors that should theoretically influence cortisol responses in these opposite sex contexts, which may be important for understanding individual variability in mating behavior. For example, one study demonstrated that men who perceived their interaction partner as more attractive had larger cortisol increases than those who perceived her as less attractive (van der Meij et al., 2010). The authors of this study speculated that cortisol increased as a result of mating apprehension (i.e., concerns about rejection). Accordingly, personal or situational characteristics that increase mating apprehension might be key predictors of mating-relevant cortisol increases. Indeed, the mating context is simultaneously shaped by both members of the social exchange; mating apprehension could increase either because the target person has high mate value or because the perceiver's own mate value is relatively low. In addition, prior work has investigated cortisol levels among men *or* women, but not both, precluding a direct examination of gender differences within the same mating context. Based on these gaps in the literature, the current study investigated perceived desirability as a dating partner for both male and female participants and their study partner. Participants' self-esteem, rejection sensitivity, and dating anxiety were also examined as possible predictors; these individual differences predict sensitivity to social evaluation and thus may be linked to cortisol reactivity in a mating context (Downey and Feldman, 1996; Ford and Collins, 2010).

A large body of work shows that cortisol rises in response to social evaluative threats, situations that have the potential for negative performance evaluation (Dickerson and Kemeny, 2004). Based on this perspective, explicit negative social evaluations (i.e., rejection from a potential mate) should elicit particularly strong cortisol increases compared to neutral or explicit positive social evaluations. Existing work in the mating literature has not examined this possibility. However, related research using a variety of explicit versus ambiguous rejection paradigms from both same-sex versus opposite-sex people is mixed; some studies show that cortisol increases in response to rejection (Blackhart, Eckel, & Tice, 2007; Ford and Collins, 2010), whereas others do not (Linnen, Ellenbogen, Cardoso, & Joober, 2012; Zwolinski, 2012). The current research examined cortisol responses to brief non-face-to-face social exchanges with an opposite-sex partner, coupled with rejecting versus accepting versus no feedback from that person.

To accomplish our goals, we asked college-aged men and women to make a short video introducing themselves to another participant. During a separate appointment a few weeks later, participants watched a 1.5-min video of an opposite-sex person introducing himself/herself, and were led to believe that the other person was watching their video. In reality, the other participant did not exist and will hereafter be referred to as the confederate. Participants were told that they would get to know the confederate more during a subsequent live web-chat, and they could exchange email addresses at the end of the study if they desired to do so. The web chat never took place (due to ostensible technical difficulties) and participants were given either rejection, acceptance, or no feedback from the confederate. Based on the existing mating literature (López et al., 2009; Roney et al., 2010, 2007; van der Meij et al., 2010), we hypothesized that (a) participants' cortisol levels would increase from before to after watching the confederate's video, (b) people who perceived the confederate to be more desirable would have higher cortisol than those who perceived him/her to be less desirable, and (c) participants who were rated as less desirable by independent coders would have stronger cortisol responses than those rated as more desirable. Based on the social-evaluative threat literature (Dickerson and Kemeny, 2004), we also hypothesized that (d) cortisol levels would be highest among rejected participants compared with everyone else. Finally, we explored whether people with lower self-esteem, higher rejection sensitivity, or higher dating anxiety might have particularly strong cortisol increases over time.

Existing research has focused on actual in-person interactions or lengthy videos with an explicit mating context. Within modern cultural contexts, a large portion of mating-related interactions occur during brief social exchanges (e.g., via social media, video messaging, dating websites). Thus, extending prior work to include brief non-face-to-face social exchanges will provide an important extension of prior research within a modern day setting.

2. Method

2.1. Participants

Students from a large public university ($N = 123$) participated in a parent study about the effects of rejection on social behavior. Individuals were eligible for the study if they were single, heterosexual or bisexual, and currently looking for a romantic relationship. Due to the nature of the parent study, women who were using hormonal birth control were not eligible to participate. Three participants (one from each condition) were excluded from all analyses because they did not follow study procedures. For example, one participant had previous knowledge of the tasks used in the parent study, and thus could not complete those tasks. Another three participants (all from the rejection condition) were excluded because they did not believe the deception. This left 117 participants across the rejection (17 male, 21 female), no feedback (18 male, 21 female), and acceptance (18 male, 22 female) conditions. Participants ranged in age from 18 to 31 ($M = 19.13$, $SD = 1.76$). Approximately 81% of participants were Caucasian, 10% were Latino/a, 4% were Asian, 1% were American Indian, 1% were African American, and 3% self-identified as "other." Individuals received $25 or partial credit towards an introductory psychology research requirement for participating in the study.

2.2. Procedure

Participants were recruited for a two-part study about social interactions. During their first appointment, they completed individual difference measures (see the materials section for details) and created a 2–3 min "getting-to-know-you" video describing themselves; they were told that another participant would watch their video during the second appointment. Based on prior research about salivary hormone assessments, participants were asked to avoid taking a nap or brushing their teeth and limit alcohol use, exercise, acidic and high sugar foods, and caffeinated drinks before their second appointment (Schultheiss and Stanton, 2012).

Everyone's second appointment was conducted between 2–8pm to control for diurnal variation in cortisol (Kirschbaum and Hellhammer, 1989; Schultheiss and Stanton, 2012). Due to the nature of the parent study, female participants' second appointments were scheduled during the first 10 days (the early follicular stage) of their menstrual cycle. At the beginning of their second appointment, all participants completed a short health behavior questionnaire assessing their sleep the prior night and provided their first saliva sample. As part of the cover story, participants were told that the first activity was about the influence of modern technology on romantic relationship development. This information helped make the mating context salient. Participants were further told that they were randomly matched with an opposite-sex participant to (a) exchange "getting-to-know-you" videos from their first appointment and (b) complete a live web-chat. Participants were

told they could exchange email addresses with the confederate at the end of the study, if they were interested in doing so.

Participants then watched the "getting-to-know-you" video ostensibly made by the confederate during his/her first appointment. They were also led to believe that the confederate was simultaneously watching their video. In reality, participants watched a standardized video created by the experimenter. When designing the study, we created 4 videos using 2 male and 2 female confederates and the same pre-written script. We designed the video script to be gender neutral and about a person who was likable and interesting to the typical college student (see online supplemental material). Participants were randomly assigned to watch one of two opposite-sex videos.

After watching the confederate's video, a second experimenter (who was purportedly working with the confederate) entered the room to set up the web chat. The experimenter ostensibly had problems with the web chat and gave participants one of three feedback types: rejection, no feedback, or acceptance (see online supplemental material for the complete script). Participants in all three conditions were told that the web chat program was not working, so they would be moving on to the next activity early. Those in the no feedback condition were given no additional information. Those in the acceptance condition were told that the confederate was interested in getting to know them during the web chat and were given his/her email address. Those in the rejection condition were told that the confederate indicated he/she was not really interested in getting to know them.

Participants provided 3 additional saliva samples at 17 min intervals following the feedback manipulation. They also completed a variety of questionnaires as part of the parent study. Participants were probed for suspicion using a funneled debrief procedure and then carefully debriefed. As described above, 3 participants were dropped due to suspicion about the experimental procedure. After the entire study was over, independent coders rated the participants' getting-to-know-you videos on a number of dimensions, as described in the materials section. All participants provided written informed consent to participate and this study was approved by the university's institutional review board.

2.3. Materials and questionnaires – first appointment

2.3.1. Self-esteem

Participants completed the Rosenberg Self-Esteem scale, a 10-item widely used measure of self-esteem ($\alpha = 0.90$; Rosenberg, 1986). Example items include "On the whole I am satisfied with myself" and "I wish I could have more respect for myself (reversed)."

2.3.2. Rejection sensitivity

Participants also filled out the 8-item short-version of the Rejection Sensitivity questionnaire ($\alpha = 0.73$; Downey and Feldman, 1996). Each item represents a social interaction that has the possibility of involving rejection (e.g., "You ask your boyfriend/girlfriend if he/she really loves you"). Participants were asked how concerned they would be about the interaction (rejection concern) and their perceptions about the likelihood of a positive response from the other person (acceptance expectancy). As per the scoring instructions, the rejection concern and acceptance expectancy (reversed) scores for each scenario are multiplied, and the resulting multiplicative terms are averaged across all of the items (Downey and Feldman, 1996).

2.3.3. Dating anxiety

Participants completed the 14-item Dating Anxiety Scale, assessing the degree of anxiety people have about dating-related contact with people of the opposite sex ($\alpha = 0.95$; Calvert, Moore, & Jensen, 1987). Example items include "Starting a conversation with someone of the opposite sex that you never met before" and "Trying to make a good impression while on a date."

2.3.4. Ratings by independent coders

A set of 4 independent coders blind to the study hypotheses rated participants' getting-to-know-you videos on 3 dimensions (see online supplemental material for the complete coding manual). They were asked "how physically attractive is this person compared to other college students?" (ICC = 0.84) and were told to focus on the objective features of how the participant looked (e.g., facial features) rather than how they styled their looks (e.g., if they were wearing make-up). Coders were also asked "How appealing is the participant's personality compared to other college students?" (ICC = 0.75). They were further informed that they should base their rating on the participants' overall demeanor and what they said during their video, rather than their physical appearance. Finally, coders were asked "To what extent do you think people of the opposite sex would be interested in dating this participant?" (ICC = 0.80). They were also told that this rating should be based on their overall global impression of participants, including their appearance, how they were dressed, how they styled their hair, and perceptions of their personality. The correlation between perceived physical attractiveness and desirability as a dating partner was very high, $r = 0.89$. Accordingly, both items were z-scored and then averaged to create a single mating desirability composite.[1] The personality dimension was weakly correlated with the other two items (range $0.28 - 0.52$), and thus was kept as a separate index.

2.4. Materials and questionnaires – second appointment

2.4.1. Feedback manipulation checks

At the end of the study, participants answered the question "What did the experimenter tell you when he/she informed you that the web chat would not happen?" The response options reflected information that was provided in the rejection, no feedback, and acceptance conditions.

At the beginning of the second appointment and again 15 min after the feedback manipulation, participants completed a 4-item measure of rejection emotions (rejected, hurt, embarrassed, humiliated; $\alpha_{T1} = 0.79$, $\alpha_{T2} = 0.91$). They rated how they felt at that moment on a scale from 0 (*not at all*) to 4 (*extremely*). Participants also completed a 2-item rejection measure ($\alpha = 0.88$) at the end of the study. They were given the prompt "Immediately after I was told that the web chat was not going to happen" and then rated the items "I felt like the other participant didn't like me at all" and "I felt rejected by the participant I was supposed to complete the web chat with." Ratings were made on a scale from 0 (*not at all true*) to 6 (*completely true*). To obtain the most complete measure of perceived rejection, the two post-feedback rejection measures were z-scored and then averaged ($\alpha = 0.70$).

2.4.2. Sleep the night prior to the appointment

Amount of sleep and waking time can affect cortisol levels (Edwards, Clow, Evans, & Hucklebridge, 2001; Leproult, Copinschi, Buxton, & Van Cauter, 1997). Accordingly, participants were asked "How many hours of sleep have you had in the last 24 hours?" and "What time did you wake up this morning?" We calculated time since waking by computing the difference between each participant's appointment and waking time. Number of hours slept and

[1] The composite was created to reduce the total number of analyses conducted and thus reduce Type 1 error across tests. The patterns were the same whether the items were left separately or averaged into a single composite.

time since waking were only weakly correlated and were thus left as separate indices, $r = 0.21$.

2.4.3. Perceptions of confederate

Participants were asked to rate the confederate after watching their video but prior to receiving the feedback manipulation. Specifically, participants were asked: "Overall, how physically attractive is the other participant?", "Overall, how attractive is the other participant's personality?", and "How appealing is the other participant as a potential dating partner?" All ratings were made on a 0 (*not at all*) to 6 (*very*) scale. These questions were designed to mirror the ratings made by independent coders of the actual participants, as described above. Accordingly, the physical attractiveness and desirability as a dating partner items were averaged into a single composite, $r = 0.69$.[2] The personality item was left separate in line with the coder ratings.

2.4.4. Hormonal measures

Participants provided 4 saliva samples throughout the study, one before the video exchange, and then again at 17 min intervals following the feedback manipulation (Dickerson and Kemeny, 2004). All samples were collected in a microcentrifuge tube via a passive drool technique (no gum or other salivary stimulant used), immediately frozen at −20 °C, and later sent to an independent lab for analysis (Kirschbaum, Technical University of Dresden). After thawing, salivettes were centrifuged at 3000 rpm for 5 min, which resulted in a clear supernatant of low viscosity. Salivary concentrations were measured using commercially available chemiluminescence immunoassay with high sensitivity (IBL International, Hamburg, Germany). The intra- and inter- assay coefficients of variation were below 8%.

The cortisol data were examined for outliers. Cortisol data from 1 participant was excluded from the analyses because all 4 sample values were more than 4 standard deviations above the sample mean. The distribution of cortisol values was moderately skewed and was thus square root transformed prior to analysis.

2.5. Data analytic strategy

An analysis of variance was utilized to assess the manipulation check. Otherwise, mixed models were used to account for correlations within subjects because several observations were obtained for each participant. All mixed models were analyzed with SPSS 22.0 (IBM, New York) using a random intercept for participant and an identity covariance structure. Every analysis included time and feedback condition as fixed predictors. Waking time and amount of sleep the prior night were also included as covariates based on prior research linking both to cortisol levels (Edwards et al., 2001; Leproult et al., 1997).

The primary analyses examined whether the video exchange increased cortisol levels over baseline. To accomplish this goal, we examined both the main effect of time and a quadratic time effect. The quadratic term allowed us to capture the expected increase in cortisol from baseline to the time of the video exchange along with a subsequent decrease (Dickerson and Kemeny, 2004; Roney et al., 2007).

Next, we investigated whether some people had stronger cortisol reactivity to the video exchange than others. Because our focus was on reactivity, we included baseline cortisol levels as a covariate in all remaining analyses (in addition to the other covariates that were included in the primary analysis, described above). Thus, we no longer included the quadratic effect of time in these analyses. We examined whether cortisol levels differed based on (a) feedback condition, (b) participants' perceptions of the confederate, (c) independent coders' ratings of the participant, and (d) socially-relevant individual differences (i.e., self-esteem, rejection sensitivity, dating anxiety, and gender). These analyses included the main effect of the key predictor, the main effect of time, and the interaction between the two. Significant interactions were decomposed by examining the effect of the predictor within each time point (i.e., the video exchange and both post-video exchange samples). Reported means are covariate adjusted and all coefficients are unstandardized.

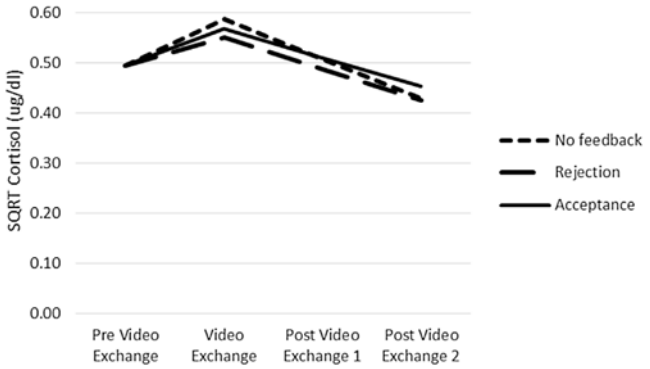

Fig. 1. Trajectory of cortisol over time by feedback condition.
Caption: Estimated marginal means were obtained from a model examining the feedback condition by time interaction, adjusting for baseline cortisol, time since waking, and hours slept the prior night. Data points were graphed for participants within each condition. Refer to the online supplemental material for cortisol values that were transformed back to their original scale.

3. Results

3.1. Feedback manipulation checks

All participants correctly identified the rejection, no feedback, or acceptance feedback they were given. Furthermore, participants in the rejection condition felt significantly more rejected than those in the no feedback and acceptance conditions, $t(113) = 6.85$, $p < 0.001$ and $t(113) = 7.56$, $p < 0.001$.

3.2. Time predicting cortisol reactivity

As predicted, the quadratic effect of time was significant, $F(1,341) = 49.45$, $p < 0.001$. Follow-up contrasts revealed that cortisol levels increased from baseline to the time of the video exchange, $t(340) = -6.00$, $p < 0.001$ (see Table 1 for a summary of all of the results at the time of the video exchange). Cortisol levels were no longer significantly different from baseline at the first recovery assessment, $t(340) = -0.02$, $p = 0.987$. In addition, cortisol levels decreased below baseline at the second recovery assessment, $t(341) = 4.18$, $p < 0.001$.

3.3. Feedback manipulation predicting cortisol reactivity

Next, we examined whether the feedback manipulation predicted cortisol reactivity, controlling for baseline cortisol levels, see Fig. 1. Contrary to expectations, the interaction between time and condition was non-significant, $F(2,225) = 2.00$, $p = 0.138$. Furthermore, cortisol levels at the time of the video exchange did not differ by condition, $F(2,139) = 0.56$, $p = 0.574$.

[2] The composite was created to (a) mirror the composite used with the coder ratings and (b) reduce the total number of analyses conducted and thus reduce Type 1 error across tests. The patterns were the same whether the items were left separately or averaged into a single composite.

Table 1
Summary of a series of follow-up analyses about the effect of each variable predicting cortisol at peak reactivity (the time of the video exchange).

	Outcome: SQRT Cortisol Levels (ug/dl)				
Type of predictor	Predictor	unstandardized coefficient (*b*)	Standard Error	*F*	*p*
a	Time (linear term)	0.01	0.01	2.023	0.156
a	Time (quadratic term)	−0.03	0.004	49.45	<0.001
a	Feedback condition*	–	–	0.56	0.574
b	Perceptions of confederate's personality	0.03	0.01	6.32	0.013
b	Perceptions of confederate's desirability as a dating partner	0.05	0.01	11.65	0.001
c	Coder ratings of participant's personality	−0.01	0.02	0.45	0.503
c	Coder ratings of participant's desirability as a dating partner	−0.03	0.01	3.44	0.066
d	Gender	−0.07	0.03	7.72	0.006
d	Dating anxiety	0.02	0.01	2.55	0.112
d	Self-esteem	−0.001	0.02	0.17	0.684
d	Rejection sensitivity	0.002	0.004	0.35	0.554

Note: Each predictor was evaluated in a separate model (as reflected in the analytic strategy and results sections), except the regular and quadratic time terms were included in the same analysis. All analyses controlled for feedback condition, baseline cortisol, time since waking, and number of hours slept the prior night. All analyses also included a linear time by predictor interaction. The only exception is the model with the quadratic effect of time, which did not include baseline cortisol levels as a covariate. These results reflect follow-up analyses that were conducted to decompose a linear time by predictor interaction and focus on the effect of the predictor at the time of the video exchange. *The unstandardized coefficient and standard error for feedback condition is not shown because it was treated as a categorical predictor with more than 2 levels. a = time and feedback manipulation, b = perceptions of confederate, c = ratings of participant, d = socially-relevant individual difference characteristics of participants.

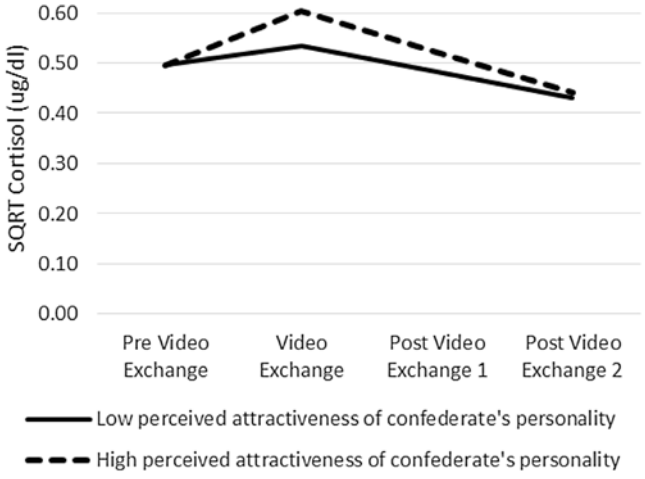

Fig. 2. Trajectory of cortisol over time by participant's perceptions of the confederate's personality.
Caption: Estimated marginal means were obtained from a model examining the key predictor by time interaction, adjusting for feedback condition, baseline cortisol, time since waking, and hours slept the prior night. Data points were graphed for participants who rated the confederate +/− 1 SD from the sample mean. Refer to the online supplemental material for cortisol values that were transformed back to their original scale.

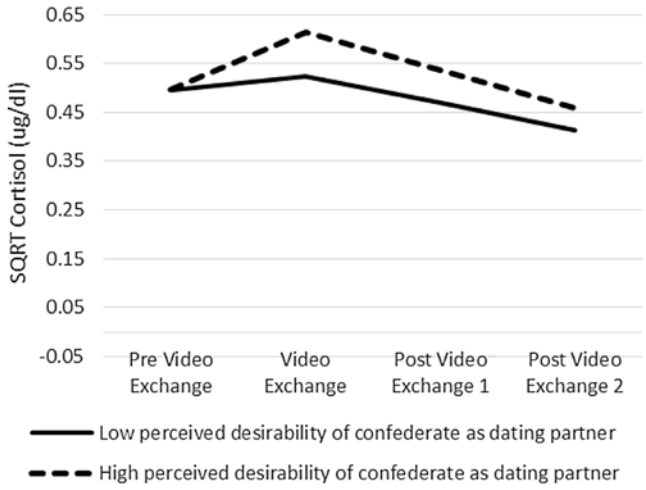

Fig. 3. Trajectory of cortisol over time by participant's perceptions of the confederate's desirability as a dating partner.
Caption: Estimated marginal means were obtained from a model examining the key predictor by time interaction, adjusting for feedback condition, baseline cortisol, time since waking, and hours slept the prior night. Data points were graphed for participants who rated the confederate +/− 1 SD from the sample mean. Refer to the online supplemental material for cortisol values that were transformed back to their original scale.

3.4. Participants' perceptions of the confederate predicting cortisol reactivity

We also investigated whether the main effect of time was moderated by participants' perceptions of the confederate (see Figs. 2 and 3). The interaction between time and ratings of the confederate's personality was significant, $F(1,226) = 9.20$, $p = 0.003$. Follow-up simple slopes tests indicated that perceptions of the confederate's personality were unrelated to cortisol levels for the first and second recovery sample, $t(109) = 1.55$, $p = 0.125$ and $t(141) = 0.39$, $p = 0.701$. However, people who perceived the confederate's personality as more attractive (+1SD) had higher cortisol levels at the time of the video exchange compared with those who perceived it as less attractive (-1SD), $t(139) = 2.52$, $p = 0.013$.

There was also a significant interaction between time and ratings of the confederate's desirability as a dating partner, $F(1,226) = 5.60$, $p = 0.019$. Follow-up simple slopes tests indicated people who perceived the confederate as a more desirable dating partner (+1SD) had higher cortisol levels at the time of the video exchange and the first recovery sample compared with those who perceived him/her as a less desirable dating partner (-1SD), $t(142) = 3.41$, $p = 0.001$ and $t(109) = 2.74$, $p = 0.007$. They also had marginally higher cortisol levels at the time of the second recovery sample, $t(143) = 1.71$, $p = 0.090$.[3]

3.5. Independent coders ratings of the participant predicting cortisol reactivity

Next, we examined whether the main effect of time was moderated by independent coders' ratings of the participant (see Figs. 4 and 5). The interaction between time and personality of the participant was non-significant, $F(1,214) = 0.73$, $p = 0.393$. Further-

[3] We also conducted a series of supplemental analyses that replicated the participant perception results (Section 3.4) after controlling for the corresponding independent coder rating of the participant. A detailed description of those analyses and results are reported in online supplemental material. In short, these analyses mirrored those reported in the paper.

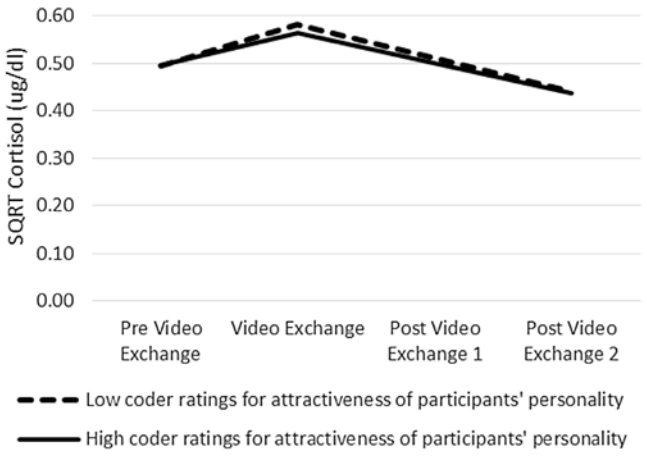

Fig. 4. Trajectory of cortisol over time by independent coder ratings for the attractiveness of the participants' personality.
Caption: Estimated marginal means were obtained from a model examining the key predictor by time interaction, adjusting for feedback condition, baseline cortisol, time since waking, and hours slept the prior night. Data points were graphed for participants who were independently rated as +/− 1 SD from the sample mean. Refer to the online supplemental material for cortisol values that were transformed back to their original scale.

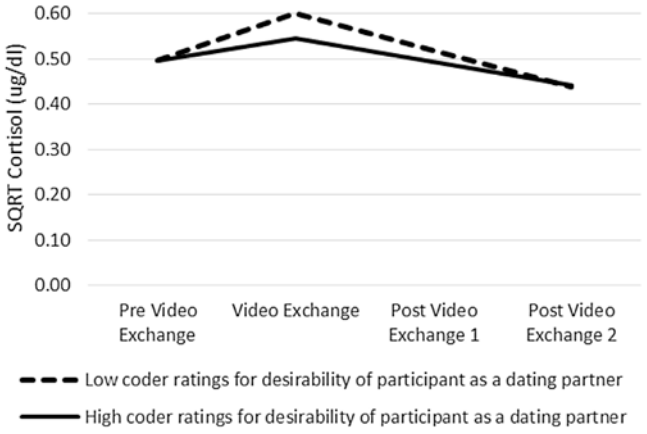

Fig. 5. Trajectory of cortisol over time by independent coder ratings of the desirability of the participant as a dating partner.
Caption: Estimated marginal means were obtained from a model examining the key predictor by time interaction, adjusting for feedback condition, baseline cortisol, time since waking, and hours slept the prior night. Data points were graphed for participants who were independently rated as +/− 1 SD from the sample mean. Refer to the online supplemental material for cortisol values that were transformed back to their original scale.

more, cortisol levels did not differ at the time of the video exchange based on the participant's personality, $t(131) = -0.67$, $p = 0.503$. However, participants' desirability as a dating partner moderated the effect of time, $F(1,213) = 8.65$, $p = 0.004$. Follow-up simple slopes tests indicated that participant's desirability as a dating partner was unrelated to cortisol levels at the first and second recovery sample, $t(103) = -0.90$, $p = 0.370$ and $t(132) = 0.16$, $p = 0.876$. However, participants who were less desirable as a dating partner (−1SD) had higher cortisol levels at the time of the video exchange compared with those who were more desirable as a dating partner (+1SD), $t(130) = -1.85$, $p = 0.066$, although this effect was only marginally significant.[4]

3.6. Socially-relevant individual differences predicting cortisol reactivity

Finally, we separately examined whether self-esteem, rejection sensitivity, dating anxiety, or gender predicted cortisol reactivity. Neither self-esteem, rejection sensitivity, nor dating anxiety moderated the effect of time, all p values >0.678. In addition, cortisol levels at the time of the video exchange did not differ by self-esteem, rejection sensitivity, or dating anxiety, all p values > 0.111. However, the gender by time interaction was significant, $F(1,225) = 12.65$, $p < 0.001$. Follow-up contrasts indicated that men and women had similar cortisol levels for the first and second recovery sample, $t(109) = -1.64$, $p = 0.105$ and $t(140) = -0.29$, $p = 0.774$. However, men had higher cortisol levels at the time of the video exchange compared with women, $t(139) = -2.78$, $p = 0.006$. Importantly, the gender results remained the same when we separately added perceived attractiveness of the confederate's personality, perceived desirability of the confederate as a dating partner, independent ratings of the participants' personality, and independent ratings of the participants' desirability as a dating partner as covariates in the model. Thus, the link between gender and cortisol levels was not explained by participants' own mate value or their perceptions of the confederate's mate value.

4. Discussion

Consistent with prior research, average cortisol levels increased in response to a brief social exchange with a member of the opposite sex. Cortisol levels typically decline throughout the day (Fries, Dettenborn, & Kirschbaum, 2009), and thus the increases over baseline evident in this study are particularly notable. Cortisol levels at the time of the video exchange were particularly high for (a) participants who perceived the confederate as a more desirable dating partner and as having a more attractive personality, (b) participants who were independently rated as a less desirable dating partner, and (c) men. Interestingly, cortisol levels were similar for people who received rejection, acceptance, or no feedback from the confederate after the brief video exchange. In addition, cortisol levels were unrelated to chronic social sensitivity as indexed by low self-esteem, rejection sensitivity, and dating anxiety.

The current findings add significantly to the existing cortisol and mating literature by identifying individual differences that predict the degree of cortisol reactivity in mating-related contexts. The present results are consistent with the idea that mating apprehension might influence cortisol reactivity (van der Meij et al., 2010). Specifically, participants who were independently rated as having lower mate value (and who presumably felt greater mating apprehension as a result) had stronger cortisol responses than those with higher mate value. Similarly, participants who viewed the confederate as a more desirable dating partner had stronger cortisol responses than participants who viewed the confederate as less desirable. Interestingly, men had stronger cortisol responses to the brief non-face-to-face social exchange than women. These effects were not explained by men's own mate value or their perceptions of the confederate's desirability as a dating partner. College-aged men are often expected to initiate mating-related behaviors, particularly behaviors with sexual undertones (Bartoli and Clark, 2006). Accordingly, mating apprehension might be particularly strong among men engaging in opposite-sex interactions because of their role as the initiator, an important avenue for further research. Taken together, the results of the current study suggest that cortisol rises in response to a brief social exchange with a member of the oppo-

[4] We also conducted a series of supplemental analyses that replicated the independent coder results (Section 3.5) after controlling for the corresponding participant perception rating. A detailed description of those analyses and results are reported in online supplemental material. In short, these analyses mirrored those reported in the paper.

site sex, and people with higher mating apprehension might have particularly strong cortisol reactivity.

Prior research has consistently demonstrated that cortisol rises in the context of opposite sex interactions but declines or remains stable in response to same-sex interactions (Roney et al., 2010, 2007; van der Meij et al., 2010). The current study thus focused on opposite-sex interactions, extending prior work by investigating individual differences *within* the mating context. The present study also advanced prior work in an important new direction by demonstrating that these cortisol increases also occur during brief non-face-to-face social exchanges. In this study, participants simply watched a 1.5-min video of the confederate introducing himself/herself and anticipated an upcoming web chat. Furthermore, the confederate introduced himself/herself as a typical college student and did not mention dating, physical attraction, or any other mating-related topics (see the online supplemental material for the full script). Although participants were under the impression that they would complete a web chat with the confederate later in the study, the web chat never happened. Accordingly, merely watching a short video, anticipating a subsequent live web chat, or a combination of the two elevated cortisol levels over baseline. Within modern cultural contexts, a large portion of mating-related interactions occur in these brief social exchanges (e.g., via social media, video messaging, dating websites). Accordingly, extending prior work to relatively brief social exchanges is an important extension of existing work. Understanding additional boundary conditions of cortisol reactivity in social contexts is an important direction for future research.

The current study adds to a small but growing literature about the effects of rejection on cortisol levels. From a social-evaluative threat perspective, cortisol levels would theoretically rise in response to rejection, a specific and potentially potent form of social-evaluative threat. However, research in support of this hypothesis is mixed; some studies show that cortisol increases in response to rejection (Blackhart et al., 2007; Ford and Collins, 2010), whereas others do not (Linnen et al., 2012; Zwolinski, 2012). The present research demonstrated that cortisol levels were similar among people who received rejection, acceptance, or no feedback from the opposite sex confederate. These data support previous findings showing similar non-effects of rejection on cortisol. Importantly, cortisol levels increased over baseline in all three conditions. In addition, cortisol levels at the time of the video exchange were particularly high for participants who perceived the confederate as a more desirable dating partner and as having a more attractive personality, participants who were independently rated as a less desirable dating partner, and men. These data are consistent with the argument that mating apprehension increases cortisol levels, as described above. Interestingly, this raises the possibility that social evaluative threat in the form of mating apprehension increases cortisol levels, but more explicit social evaluative threat (via overt rejection) does not. Taken together, the current results support the argument that cortisol may facilitate courtship behavior (Roney et al., 2007); cortisol levels rose in response to an opposite-sex social exchange, but did not differentiate based on the results of that exchange (i.e., rejection versus acceptance from the other person).

One critical next step is to fully understand the function and/or consequences of elevated cortisol in opposite-sex social exchanges. The present data are consistent with the argument that cortisol levels facilitate courtship behavior (Roney et al., 2007). However, very little is known about whether these cortisol increases are empirically linked to social behavior. For example, does the degree of cortisol reactivity predict the likelihood of success in that interaction? Are people who have larger cortisol responses perceived more favorably or as more desirable dating partners? Understanding the links between these brief cortisol increases and long-term health is another important avenue for future research. On the one hand, these brief moderate increases in cortisol may have a negligible direct impact on health, while simultaneously facilitating courtship behavior. Satisfying romantic relationships confer many health benefits (Robles, Slatcher, Trombello, & McGinn, 2014). Thus, mating-related cortisol increases may even indirectly improve long-term health to the extent cortisol increases improve mating success. On the other hand, not everyone is successful in obtaining a mate, and some people have frequent mating-relevant interactions over many years. Repeated activation of the hypothalamic-pituitary-adrenal (HPA) axis, resulting in cortisol release, over a long duration may have negative implications for long-term health (McEwen, 2004). Understanding the benefits and consequences of mating-relevant cortisol increases is an important avenue for future research. Finally, existing work about courtship behavior and cortisol has exclusively focused on single, heterosexual (or bisexual) men and women. Prior research has demonstrated that men have lower testosterone when they are in a relationship than when they are single, except among men seeking romantic contact outside of their relationship (McIntyre et al., 2006). These data suggest that romantically involved individuals' cortisol may only increase if they were interested in seeking romantic contact outside of their relationship.

In sum, cortisol levels reliably rose among both men and women engaging in a brief non-face-to-face social exchange with a member of the opposite sex. These cortisol increases are particularly notable given cortisol's typical diurnal decline (Fries et al., 2009). Cortisol levels were similar for people who received rejection, acceptance, or no feedback from the confederate. Cortisol increases were particularly strong for men, participants who perceived the confederate as a more desirable dating partner, and participants who were independently rated as a less desirable dating partner. These data help shed light on cortisol reactivity within a mating context.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biopsycho.2017.01.001.

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