Contact with attractive women affects the release of cortisol in men

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ABSTRACT

Previous studies have shown that situations relevant for human mating can affect the levels of many hormones. This study focused on the hypothalamus–pituitary–adrenal axis by measuring salivary cortisol levels in 84 young men prior to and after a period of short social contact with a woman or man. Results showed that after contact with another man the cortisol levels of the participants declined according to the circadian release pattern of cortisol. However, cortisol levels in men declined less when they had contact with a woman. Furthermore, cortisol levels of men increased when they perceived the woman with whom they had contact as attractive. Our findings provide indirect evidence for the role of the hypothalamus–pituitary–adrenal axis in human courtship. During social contact with attractive women, moderate increases in cortisol levels may reflect apprehension over an opportunity for courtship.

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Introduction

Hormones have been related to many aspects of human social behavior (van Anders and Watson, 2006). Many studies investigating the hormonal changes in men with respect to the function of sexual activity and mate acquisition have focused on the hypothalamus–pituitary–gonadal axis by measuring changes in salivary testosterone levels. For example, testosterone increases after men engage in sexual intercourse (Dabbs and Mohammed, 1992), after sexual activity resulting in an orgasm (Knussman et al., 1986) and even after watching erotic videos (Hellhammer et al., 1985; Stoléru et al., 1993). However, explicit sexual stimuli are not the only cues that provoke testosterone increases, as a non-physical social contact for 15 min or for just 5 min with novel women has been shown to provoke an increase in male testosterone levels (Roney et al., 2007; van der Meij et al., 2008). It is thought that in these contexts testosterone functions to promote behavior or cognitions that facilitate mate acquisition or mating directly (Roney et al., 2003). Besides testosterone other hormones have also been found to be related to the mating and sexual behavior of men. For example, sexual arousal causes an increase in vasopressin levels (Murphy et al., 1987), masturbation provokes the release of prolactin (Exton et al., 2001; Krüger et al., 2003) as well as epinephrine and norepinephrine (Krüger et al., 2003) and sexual intercourse stimulates the release of oxytocin (Carmichael et al., 1994). This study focused on the hypothalamus–pituitary–adrenal axis (HPA) by studying its end product; cortisol, and specifically

investigated if this hormone changes in response to a brief social contact with a novel woman.

Originally it was thought that the release of cortisol was primarily caused by non-specific psychological or physiological stressors (Selye, 1956). Later studies have focused on the exact nature of these stressors and found that in situations where physical well-being is perceived to be threatened, e.g. jumping out of an airplane (Chatterton et al., 1997), can provoke an increase in the secretion of cortisol. In addition to physically threatening contexts it has also been proposed that cortisol responses are elicited when the psychological well-being is threatened (for a review see Dickerson and Kemeny, 2004). More specifically, the social self preservation theory predicts that cortisol increases when individuals are motivated to maintain their social status or acceptance. Evidence for this theory is provided by cortisol increases in situations when one's self-identity can be negatively judged by others (Seeman et al., 1995), and when the outcome of a negative situation is beyond control (e.g. Peters et al., 1998; Salvador et al., 2003). The secretion of cortisol in response to stress has an adaptive function as it diverts energy to exercising muscles, enhances cardiovascular tone, and suppresses unessential processes such as digestion, growth and reproduction (Sapolsky et al., 2000). However, exposure to physical or psychological stressors for a long period of time may cause chronically elevated cortisol levels that can have adverse effects on health as it worsens various disorders, such as myopathy, adult-onset diabetes, hypertension, amenorrhea and impotency (Munck et al., 1984; McEwen, 2008).

Many researchers view the release of cortisol as a coping mechanism to aversive psychological or physical conditions. However, there is also a substantial amount of research that suggests that cortisol may have other distinct functions. For example, in the non-

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human animal literature it has been shown that corticosterone (the non-human version of cortisol) facilitates pair bonding in male prairie wolves but not in females (DeVries et al., 1996). Other studies have consistently found that corticosterone increases after copulation in a wide range of species, including stallions, bulls, pigs (Borg et al., 1991; Rabb et al., 1989), rats (Retana-Marquez et al., 1998) and mice (Bronson and Desjardins, 1982). Nevertheless, in male rats, cortico-sterone levels may increase up to two fold after males are exposed to physical or non-physical contact with a receptive or non-receptive female (Bonilla-Jaime et al., 2006). In humans the effect of cortisol on male sexual functioning is less clear. For example, while some studies have found that cortisol decreases after watching erotic videos (Uckert et al., 2003), some have found that cortisol levels do not change after watching such videos (Rowland et al., 1987; Carani et al., 1990; Exton et al., 2000). Furthermore, chronically elevated cortisol levels such as those caused by Cushing's Syndrome tend to decrease sexual functioning (Starkman and Schteingart, 1981), whereas the administration of adrenocorticotropic hormone (which stimulates cortisol secretion) to patients with erectile dysfunction increases their sexual performance (Isidori et al., 1984).

Only one recent study assessed if men increase their cortisol levels in response to contact with women (Roney et al., 2007). In the first experiment of this study, men had to wait with a female confederate of the experimenter or had to wait alone. Their results showed that compared with waiting alone, cortisol increased after social contact with a woman. In their second experiment men interacted with a female experimenter who attempted to be flirtatious and signal interest or with a male experimenter who attempted a friendly conversation. This time they found that there was a non-significant cortisol increase after contact with a female experimenter and a significant decrease in cortisol after contact with a male experimenter. These findings suggest that it depends on the social context whether contact with women provokes an increase in male cortisol levels.

The present study tried to clarify the role of cortisol changes in men who are in a social environment where there is the potential for courtship. But when do men perceive a situation as potentially suitable to engage in courtship? In humans, due to our psychological complexity, the perception of such a situation is probably quite variable. In this study we considered that for most men the presence of an attractive woman may induce the perception that there is an opportunity for courtship. While some men might avoid attractive women since they might think they are 'out of their league', we predicted that the majority of men would respond with some apprehension and a concurrent hormonal response. To test this hypothesis, our study investigated the hormonal responses of men when they came into contact with a novel woman. An informal setting was staged in which male participants had to wait in a waiting room situation with either a female confederate or a male confederate. Salivary cortisol levels were measured before and after the contact period. We expected that as the female confederate was perceived as more attractive, participants would show a more pronounced change in cortisol after meeting this woman, whereas the perceived attractiveness of the male confederate would not affect cortisol levels.

Method

Participants

Eighty-four male students (mean age: 21.2 years ± 0.32) partici-pated in this study in exchange for €10. The participants had a mean body mass index of 23.5 (±0.46) and were all Caucasian. Subjective socio-economic status (Adler et al., 2000) was measured on a scale from 1 (lowest) through 10 (highest) and the participants reported a mean subjective socio-economic status of 6.6 (±0.09). To recruit participants a male and female research assistant approached men in

the cafeterias of the University of Valencia and held talks just before the start of several lectures.

All participants were first interviewed by a male or female collaborator and were asked to complete a questionnaire. We excluded individuals who were not heterosexual (open question: what is your sexual orientation?), who were enrolled in a psychology degree, and those who smoked more than 5 cigarettes a day or reported a serious medical or psychological problem or drug abuse. Participants were also excluded if they were using any medication directly related to cardiac, emotional or cognitive function, or one that was able to influence hormonal levels, such as glucocorticoids or β-blockers. One participant was excluded from analyses because after participating he indicated he was bisexual.

Up until 1 day before the experiment, the participants were asked to maintain their typical habits, including sleeping for as long as usual. Additionally, they were instructed to refrain from alcohol consump-tion and any heavy physical activity the day before the session. Furthermore, during the 2 h immediately prior to the session participants were asked to drink only water and avoid any stimulants, such as coffee, cola, caffeine, tea or chocolate. All participants received verbal information about the study and signed an informed consent form about the general procedure of the study and the measurements taken. Participants were not informed that they would have to wait for 5 min with another individual. This study was approved by the ethical committee of the Faculty of Psychology (University of Valencia).

Stimulus persons

Each participant came into contact with either a male or female confederate of the experimenter. In order to achieve this, twelve men and six women played the role of stimulus person. Confederates (mean age: 23.33 years ± 0.55) were chosen on the basis of being moderately attractive falling within an age matched range to the participants. After the contact period, each participant rated the attractiveness of the stimulus person they encountered on a scale from 1 (not attractive) to 7 (very much attractive). The male stimulus persons received an average attractiveness rating of 2.37 (±0.23) and the female stimulus persons received a 4.73 (±0.18). All stimulus persons received the instructions to engage in friendly conversation in a natural manner, were instructed to act as if they were participants in the same study, and were told to allow long pauses if the participants elected not to talk.

Procedure

Upon arrival at the laboratory the participants were greeted by the male experimenter and were briefed on the general procedure of the study. To avoid confounds, the experimenter did not engage socially and kept contact to a minimum. Participants filled in an informed consent form and their height and weight was measured.

As part of a larger study participants first performed a competitive computer task which randomly assigned half of the participants to a winner condition and the other half to a loser condition (for detailed information see: van der Meij et al., 2010). On this task, participants competed face-to-face on items similar to those used in intelligence tests. At the end of the task their computer screen announced if they had won or lost. Participants were told that winners would receive €10 and losers €5. However, the outcome of the task was manipulated by the experimenter and therefore at the end of the experiment each participant received €10. Subsequent to this study, for each previous condition half of the participants were then randomly assigned to have contact with a man and the other half to have contact with a woman.

Approximately 5 min after having heard the explanation of the study participants provided a saliva sample (C1) for the measurement

of their cortisol level and worked on the computer task. Ten minutes after the completion of this task, the participants provided another saliva sample (C2). Participants were then brought into a room where they were instructed to work on a Sudoku. Within this room there was a confederate who appeared to be another participant completing a similar puzzle task. Upon entering the room the experimenter indicated he did not have the correct version of the puzzle for the participant. The participant and stimulus person were then asked to wait, so the experimenter could get the correct version. The experimenter then left and the participant and the stimulus person were left alone to wait together for 5 min.

After this, the experimenter returned with the correct version. The participants received the instruction to work on the Sudoku in a relaxed manner and were told that the only purpose of the puzzle was to keep them occupied until the next saliva sample. Then the stimulus person left the room with the experimenter. After working for 15 min on the Sudoku, the experimenter returned to collect the puzzle from the participant and asked the participant to provide a third saliva sample (C3).

Finally, participants were debriefed about the true nature of the experiment, and received €10. The whole procedure lasted one and a half hours and sessions were held from 16.00 h to 20.00 h to control for fluctuations in the circadian rhythm of cortisol (Weitzman et al., 1971).

Hormonal assays

Three saliva samples were collected by passive drool. Participants deposited 5 ml of saliva in plastic vials which took approximately 5 min to fill. The samples were frozen at −20 °C until the analyses were done. The samples were analyzed by a competitive solid phase radioimmunoassay (tube coated), using the commercial kit Coat-A-Count C (DPC, Siemens Medical Solutions Diagnostics). The within and inter assay variation coefficients were all below 8%. Two outliers were removed since these participants had cortisol values which differed by more than 3 standard deviations from the mean.

Statistical analysis

We first performed several independent *t*-tests to assess if there were any differences between conditions for the socio-demographic variables and baseline cortisol levels. To investigate if the task before the contact period produced a cortisol change we performed a repeated-measures ANOVA, with result of the task (winner or loser) as a between-subjects factor and moment (cortisol level before and after the task) as a within-subject factor. A Spearman correlation was used to investigate if starting time of the experiment affected the cortisol measurements and the perceived attractiveness of the stimulus persons.

To investigate if the contact period and the sex of the stimulus person provoked a change in salivary cortisol levels, we performed a repeated-measures ANCOVA with sex of the stimulus person (male or female) as a between-subjects factor and moment [cortisol level before (C2) and after contact (C3)] as a within-subject factor. We included age, the cortisol change from before to after the computer task and the result from this task (winner or loser) as covariates to control for their possible influence. When a significant effect was found, post hoc planned comparisons were performed using the Bonferroni adjustments for the *p*-values. We also investigated via an independent *t*-test if the percent change in cortisol levels was different between participants who had contact with a female or male stimulus person.

To test if the absolute cortisol change (C3–C2) and the cortisol percent change [(C3/C2)*100 − 100] were both related to the perceived attractiveness of the female or male stimulus persons we performed Pearson correlations. A value of $p < 0.05$ (two-tailed) was considered

statistically significant. Statistical tests were performed with SPSS version 15.0. When not otherwise specified values are Mean ± Sem.

Results

Preliminary analysis

There were no differences between conditions for the following variables: age, height, weight, BMI, subjective socio-economic status, educational level, average weekly physical activity, and alcohol use (*t*-tests, all $p \geq 0.24$). Cortisol levels before the contact period were no different between conditions, $t(79) = 1.37, p = 0.176$. The task previous to the contact period did not provoke a change in cortisol levels, $F(1,79) = 0.27, p = 0.606$, nor was there an interaction between moment of cortisol measurement and the result of this task, $F(1,79) = 1.54, p = 0.219$. Finally, there was no relation between the starting time of the experiment, nor with cortisol levels or the perceived attractiveness of the stimulus persons, all $p \geq 0.140$.

Cortisol and social contact

There was no effect of moment on cortisol levels, $F(1,76) = 1.18, p = 0.281$, but there was a significant interaction between the sex of the stimulus person and moment, $F(1,76) = 10.80, p = 0.002$ (see Fig. 1). Participants who had contact with a man decreased their cortisol levels more, $F(1,76) = 56.71, p < 0.001$, than participants who had contact with a woman, $F(1,76) = 7.82, p = 0.007$. These results remained significant when excluding the covariates: (i) result of the computer task and (ii) cortisol change from before to after the task. Among participants who had contact with a man absolute cortisol levels decreased on average with −2.19 nmol/L (±0.3), whereas among participants who had contact with a woman absolute cortisol levels decreased with only −0.86 nmol/L (±0.4). The cortisol levels among participants who had contact with a man decreased on average with −26.9% (±2.2), whereas among participants who had contact with a woman the relative cortisol change was no more than 0.1% (±7.9), $t(79) = −3.33, p = 0.001$.

Cortisol change and the attractiveness of the stimulus person

The absolute cortisol change during contact with a male stimulus person was not related to the perceived attractiveness of the male stimulus persons, $r_{41} = 0.198, p = 0.215$ (see Fig. 2b). However,
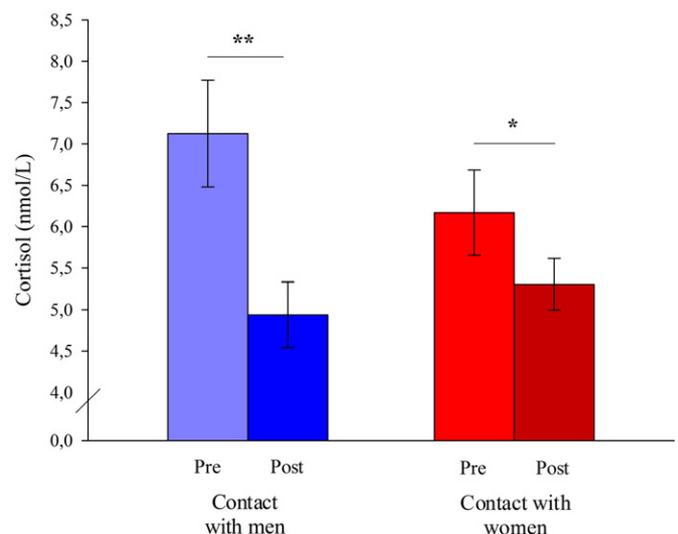
Fig. 1. Cortisol levels before (pre) and after (post) the contact period, separated for the sex of the stimulus person. Values are Mean ± Sem. *$p < 0.05$, **$p \leq 0.001$.

results showed that that the absolute cortisol levels increased more as the participants perceived the females stimulus persons as more attractive, $r_{40} = 0.549$, $p < 0.001$ (see Fig. 2a). The cortisol percent change during contact with a male stimulus person was not related to the perceived attractiveness of the male stimulus persons, $r_{41} = 0.170$, $p = 0.289$ (see Fig. 3b). However, the cortisol percent change was higher as the participants perceived the female stimulus persons as more attractive, $r_{40} = 0.490$, $p = 0.001$ (see Fig. 3a).

Discussion

This study showed that male cortisol levels increased after exposure to a 5 min short social contact with a young attractive woman. This complements findings found in the non-human literature which have shown that corticosterone increases in males after a wide range of mating stimuli (Bonilla-Jaime et al., 2006). Among human males the relationship between cortisol and sexual stimuli is not so evident (Uckert et al., 2003; Carani et al., 1990; Isidori et al., 1984). Nevertheless, this study found that cortisol levels had increased after a potential situation for courtship by showing that during contact with women cortisol increased in men who perceived the women with whom they had contact as attractive.

This cortisol increase can be viewed through the perspective of the social self preservation theory which predicts that cortisol increases
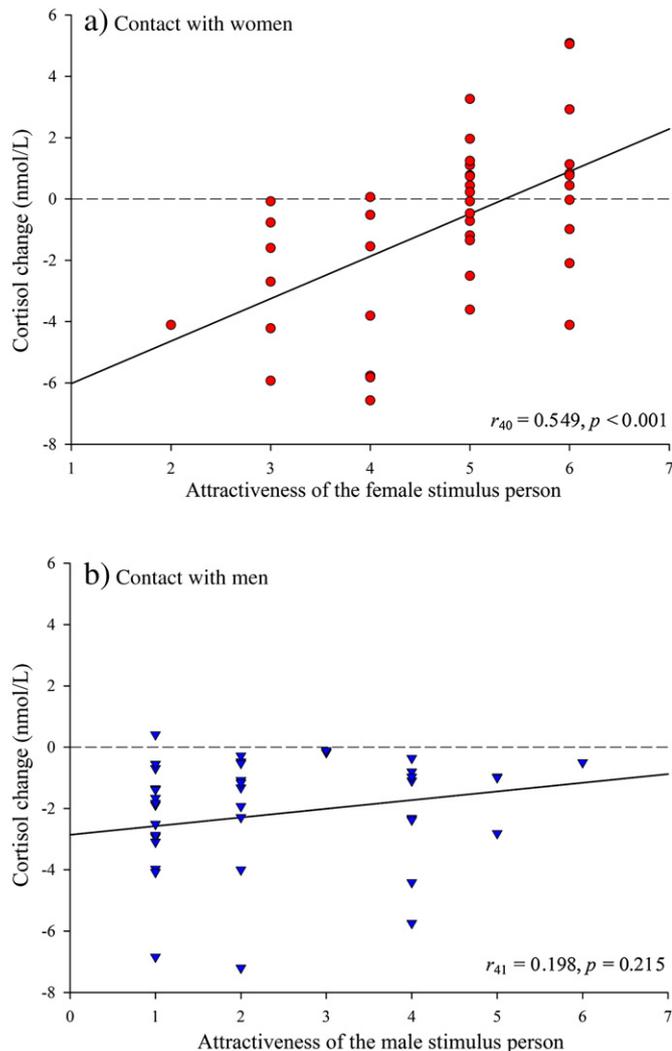
Fig. 2. The relationship between participant's absolute cortisol change and how attractive he perceived the stimulus person with whom he had contact. Separate figures are presented for contact with a female stimulus person (a) and a male stimulus person (b).
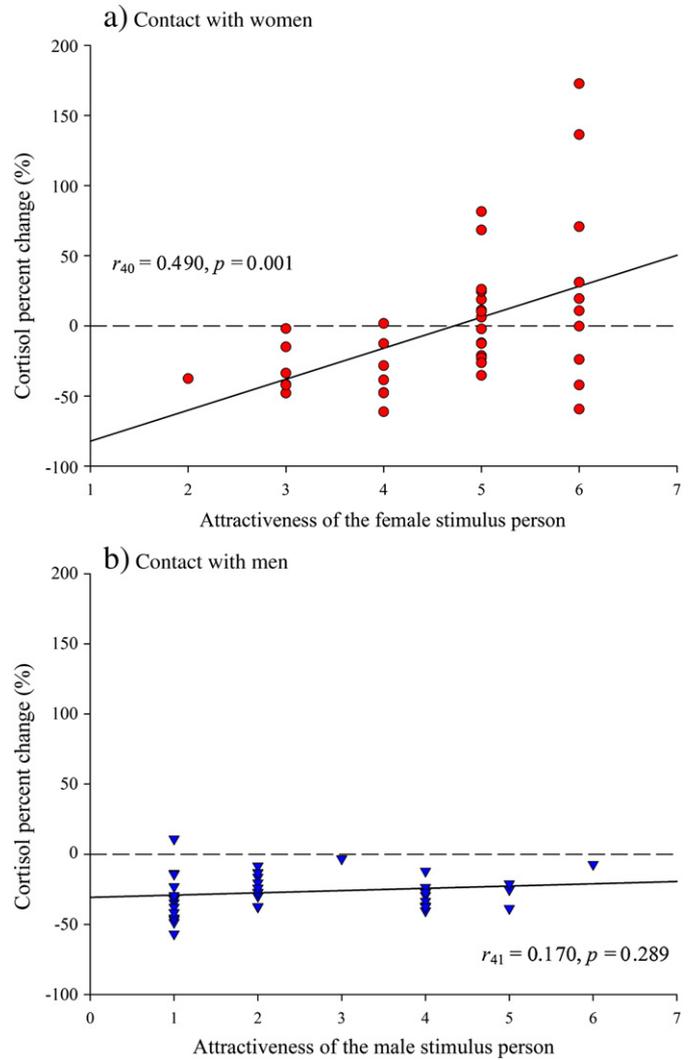
Fig. 3. The relationship between participant's cortisol percent change and how attractive he perceived the stimulus person with whom he had contact. Separate figures are presented for contact with a female stimulus person (a) and a male stimulus person (b).

when the psychological well-being is threatened (Dickerson and Kemeny, 2004). Men who perceived the female stimulus person as attractive may have viewed the contact period, consciously or unconsciously, as an opportunity for courtship. Being presented with such opportunity also entails the risk of being rejected, which could threaten psychological well-being. This threat is intensified when we consider that the contact period was (i) unpredictable: they suddenly had contact with an attractive woman without knowing for how long, and (ii) contained a social evaluative component: the attractive woman could decide that she is not interested. According to the social self preservation theory these are exactly the components which provoke a cortisol increase (Dickerson and Kemeny, 2004). Following this reasoning, increased HPA-axis activity during contact with attractive women could reflect the motivation to maintain the social status and acceptance and therefore avoid rejection by stimulating affiliative behavior. Studies in the future could measure the behavior and situation appraisal of men to assess how they actually perceive the contact period.

Without considering the attractiveness of the stimulus person we found that men maintained more stable cortisol levels when they had contact with a woman than with another man. Across conditions, absolute cortisol levels declined during the course of the experiment, which can be explained by the circadian release pattern of cortisol. The absence of an overall substantial cortisol increase after contact

with a woman seems counterintuitive, but if cortisol is to play a role in human mating it will most likely be the modest changes in cortisol levels that facilitate male courtship, since large acute stress-like doses of cortisol actually suppress sexual functioning (for a review see Sapolsky et al. (2000)).

Unlike the present study, Roney et al. (2007) did find a modest increase in male cortisol levels after contact with novel women irrespective of the attractiveness of this woman. An explanation for this discrepant finding is that the stimulus in our study was weaker since our contact period was just 5 min in duration, where as Roney et al. (2007) used a contact period of 15 min. The results of their second experiment were more consistent with this study since they found a cortisol decrease after social contact with a male experimenter and no significant cortisol change after social contact with a female experimenter. These mixed results can be explained by taking in to account the attractiveness of the stimulus person, i.e. men only experience increases in cortisol levels when they perceive the woman with whom they have contact as attractive. To our knowledge, the study of Roney et al. (2007) did measure attractiveness but did not control for this variable when testing the cortisol responses of participants.

Our study provides evidence that interpersonal interaction can influence the secretion of cortisol. That this secretion in heterosexual men is affected by the perceived attractiveness of the woman with whom they are interacting, raises the possibility that elevated levels of this hormone may, in some yet undetermined way, affect the character of courtship interactions between men and women.

Acknowledgments

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