Repeatedly adopting power postures does not affect hormonal correlates of dominance and affiliative behavior

Hannah Metzler Corresp., [1, 2] , **Julie Grèzes** Corresp. [1]

[1] Laboratoire de neurosciences cognitives, INSERM U960, Département d'études cognitives, Ecole Normale Supérieure de Paris, PSL University, Paris, France
[2] Sorbonne Universités, Université Pierre et Marie Curie (Paris VI), Paris, France

Corresponding Authors: Hannah Metzler, Julie Grèzes
Email address: hannahmetzler1@gmail.com, julie.grezes@ens.fr

Background. Adopting expansive versus constrictive postures related to high versus low levels of social power has been suggested to induce changes in testosterone and cortisol levels, and thereby to mimic hormonal correlates of dominance behavior. However, these findings have been challenged by several non-replications recently. Although there is thus more evidence against than for such posture effects on hormones, the question remains as to whether repeatedly holding postures over time and/or assessing hormonal responses at different time points would yield different outcomes. The current study assesses these methodological characteristics as possible reasons for previous null-findings. By testing effects of repeated but short posture manipulations in a social context while using a cover-story, it further fulfills the conditions previously raised as potentially necessary for the effects to occur.

Methods. 82 male participants repeatedly adopted an expansive or constrictive posture for 2 minutes in between blocks of a task that consisted in categorizing faces based on first impressions. Saliva samples were taken at two different time points in a time window in which hormonal responses to stress, competition and other manipulations are known to be strongest.

Results. Neither testosterone and cortisol levels linked to dominance behaviors, nor progesterone levels related to affiliative tendencies, changed from before to after adopting expansive or constrictive postures. The present results establish that even repeated power posing in a context where social stimuli are task-relevant does not elicit changes in hormone levels.

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[2] Sorbonne Université, UPMC University Paris 06, Paris, France

Corresponding Authors:
Hannah Metzler[1, 2]
Email address: hannahmetzler1@gmail.com

Julie Grèzes[1]
Email address: julie.grezes@ens.fr

Abstract

Background. Adopting expansive versus constrictive postures related to high versus low levels of social power has been suggested to induce changes in testosterone and cortisol levels, and thereby to mimic hormonal correlates of dominance behavior. However, these findings have been challenged by several non-replications recently. Although there is thus more evidence against than for such posture effects on hormones, the question remains as to whether repeatedly holding postures over time and/or assessing hormonal responses at different time points would yield different outcomes. The current study assesses these methodological characteristics as possible reasons for previous null-findings. By testing effects of repeated but short posture manipulations in a social context while using a cover-story, it further fulfills the conditions previously raised as potentially necessary for the effects to occur.

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Introduction

Individuals' position in a social hierarchy greatly determines their response to stressful situations as well as their opportunities for social contact and relationships (de Waal, 1986; Sapolsky, 2005). Because individuals' social power changes over time and across different contexts, the physiological mechanisms underlying power-related behavior need to allow flexible adaptation to new situations. Steroid hormone levels, including cortisol, testosterone and progesterone are key players in the implementation of this behavioral flexibility: not only do their baseline levels influence individuals' tendencies for certain behaviors, but their levels also change in situations that involve stress, opportunities for gaining social status or affiliating with others, or threats to social status and affiliative needs (Mehta & Josephs, 2011; Schultheiss, 2013). Although there are complex interactions between these three steroid hormones and the behaviors they modulate (Mehta & Josephs, 2011), cortisol is predominantly involved in the regulation of stress responses (Sapolsky, 1990), testosterone mediates behaviors that serve to achieve or maintain social status (Archer, 2006; Mehta & Josephs, 2011; Eisenegger, Haushofer & Fehr, 2011), and progesterone contributes to the regulation of affiliative behavior (Schultheiss, Wirth & Stanton, 2004; Wirth, 2011).

Positions of high and low power are associated with distinct endocrine profiles: while high-ranking individuals have higher baseline testosterone levels and lower cortisol levels, the reverse is observed in low-ranking individuals (Sapolsky, 1990; Virgin & Sapolsky, 1997; Mehta & Josephs, 2010). Building on theories of embodiment, which postulate that many aspects of cognition are shaped by representations of body actions, Carney, Cuddy and Yap (2010) assessed whether exhibiting non-verbal dominant or submissive behavior, namely expanding or constricting one's body, would induce corresponding changes in testosterone and cortisol levels. They did indeed observe an increase of testosterone and a decrease of cortisol in individuals who had adopted an expansive posture and the reverse changes in individuals who had adopted a constrictive posture. Although these findings seemed consistent with the hormonal correlates of status and power, four subsequent studies could not replicate them despite of large sample sizes that ensured high statistical power in three of the replications (Ranehill et al., 2015; Ronay et al., 2016; Smith & Apicella, 2017; Davis et al., 2017). In response to the first non-replication, Carney, Cuddy and Yap (2015) pointed out several methodological differences that could possibly account for the contradicting results. For example, Ranehill et al. (2015) had not used a cover story or a social filler task (later referred to as "social context" in power-posing studies) while participants held the posture. Furthermore, they had provided instructions via computer instead of having an experimenter explain the postures, and chose a longer duration for the posture manipulation. The three following replication studies addressed some of these concerns and even improved the original study's setting, for instance by testing effects in social contexts with implications for power, status and dominance, such as competition or public speaking (Smith & Apicella, 2017; Davis et al., 2017). Eventually, the direct replication of Ronay and colleagues (2016) addressed all these points and still observed no effect on hormone levels.

While expansive and constrictive postures' effects on hormones were not replicated, their effect on feelings of power and control, also originally reported by Carney et al. (2010), has been confirmed by a meta-analysis of several pre-registered, highly powered studies (Gronau et al., 2017). A p-curve analysis further suggests that the existing literature contains evidence for such an effect on feelings of power (Cuddy, Schultz & Fosse, 2018), although this analysis remains unspecific about the direction of the effect (see Credé, 2018). Regardless of the null-findings for hormones, this evidence for posture effects on feelings of power and other emotional and affective self-report measures have led Cuddy et al. (2018) to call for more studies on psychophysiological outcomes. Specifically, they suggest that future experiments should apply more precise hormone methods or assess incremental effects of adopting a posture several times. Davis et al. (2017) have also raised the question of whether null-effects for hormones could be related to the timing and dose of the posture manipulation. They speculated that larger doses of posture or collection of samples at different time points after the posture could yield different outcomes. Indeed, adopting expansive postures for about 15 minutes throughout a stressful experience boosted the cortisol response to stress (Turan, 2015). This suggests that expansive postures are maladaptive in certain contexts, but also illustrates that adopting postures for longer durations may induce hormonal changes. Altogether, it appears that additional empirical evidence is necessary to reach final conclusions about whether expansive and constrictive postures do or do not induce changes in hormone levels at different time points than assessed previously or when adopted for longer durations.

In 2015, before the publication of the first non-replication of the power posing effect on hormone levels, we collected data which we believe can contribute to the ongoing discussion about whether expansive and constrictive postures induce changes in hormone levels. The design of our study meets most of the criteria Carney et al. (2015) listed as potentially necessary conditions to observe postural feedback effects. First, postural effects on hormones were measured in a social context: saliva samples were collected as part of another study (Metzler, unpublished data) during which participants had to categorize faces according to their first impression while repeatedly adopting postures between task blocks. This task resembles the social filler task in the original study (Carney et al., 2010), in which subjects also formed impressions by looking at people's faces. Second, this setting provided a credible cover story, i.e. that the saliva samples were collected to assess associations between face categorization and physiological indices. None of the participants associated the collection of saliva samples to the posture manipulation. Third, we did not use computerized instructions, but instead kept the experimenter blind to participant's posture condition for as long as possible during the instructions in order to minimize experimenter biases. Fourth, participants adopted the expansive or constrictive posture for maximum two minutes at a time, which avoids discomfort that might lessen the posture's effect.

Moreover, our study is the first to provide an answer to questions regarding the "dose" of posture and the timing of hormone measurement recently raised by Cuddy et al. (2018) and Davis et al. (2017). It investigated the incremental effects of repeatedly adopting the same posture, by having participants adopt their assigned posture three times, with 10-12 minutes in between during which they performed the face categorization task. Participants were further encouraged to adopt an open or closed sitting position, similar to their assigned posture, while performing the task. Together, the repeated 2 minute periods in which participants adapted one of two postures chosen from Carney et al. (2010), together with the encouragement of a similar, but freely adaptable sitting position during the face categorization task, add up to a “larger dose” of posture while avoiding discomfort. Finally, we measured hormone levels at longer time intervals than previous studies, collecting two post-posture saliva samples at approximately 23 and 36 minutes after the beginning of the first posture.

Finally, we evaluated the possible effect of postures on affiliation motivation as evident in progesterone levels. Indeed, the existing and above-mentioned literature on postural feedback effects has so far focused on power-related behavior and hormones. Yet, there is considerable evidence that power also impacts on individuals affiliative tendencies (Magee & Smith, 2013; Guinote, 2017). For instance, lack of power enhances motivation to connect with others (Lammers et al., 2012; Case, Conlon & Maner, 2015) and cues of low social status have positive effects on pro-social behavior (Guinote et al., 2015). Moreover, facing threats and stressful situations can enhance affiliative motivation and behavior (Schachter, 1959; Gump & Kulik, 1997; Dezecache, Grèzes & Dahl, 2017), as bonding with others represents an efficient coping strategy (Taylor, 2006; Dezecache, 2015). The display of constrictive and submissive postures generally occurs in threatening situations and serves to appease aggressive conspecifics by signaling friendly intentions (Schenkel, 1967; de Waal, 1986). Adopting constrictive postures may thus be linked with affiliative tendencies. Progesterone is known to be released together with cortisol in response to stress in general, but particularly social stress (Wirth, 2011). It correlates with both naturally fluctuating (Schultheiss, Dargel & Rohde, 2003) and experimentally induced affiliative motivation (Schultheiss, Wirth & Stanton, 2004; Wirth & Schultheiss, 2006) and may promote social bonding as a coping behavior in response to stress (Wirth, 2011). A change in salivary progesterone after adopting constrictive postures would therefore indicate an increase of affiliation motivation. In summary, the current study investigated changes in salivary testosterone, cortisol and progesterone levels in response to a repeated posture manipulation in a social context.

Materials & Methods

Participants

Carney et al. (2010) reported effect-sizes of r=.34 for testosterone and r=.43 cortisol. We performed a power-analysis in G-Power (Faul et al., 2007) based on the smaller one of these two effect-sizes, i.e. r=.34. This yielded a minimal necessary sample of n=63 to achieve 80% power to detect effects as large as those of Carney et al. (2010). These were the only available effect sizes for posture effects on hormone levels when we conducted our study. Given inherent biological differences in testosterone and progesterone production between men and women, analyses of these hormones need to be done separately for each sex (Stanton, 2011). Therefore, we included only male participants to achieve sufficient power with the maximum sample size possible under our feasibility constraints.

We recruited a total of 82 male participants via a participant pool mailing list and student job advertisement websites. Participants were between 17 and 32 years old, reported not to be regular smokers or under medical treatment, and to not have a history of endocrine illness, neurological and psychiatric disorders, or dependency to alcohol or other drugs. All participants provided written informed consent and were paid for their participation. The experimental protocol was approved by INSERM and licensed by the local research ethics committee (Comité de protection des personnes Ile de France III - Project CO7-28, N° Eudract: 207-A01125-48) and carried out in accordance with the Declaration of Helsinki.

Measures

Questionnaires. For assessing potential differences between posture groups, we administered the French version of the State-Trait Anxiety Inventory (STAI, Spielberger, 1983), the BIS/BAS Scales (Caci, Deschaux & Baylé, 2007) and the Rosenberg Self-Esteem Scale (Vallières et Vallerand, 1990). Participants completed the trait measures prior to the testing session in the lab, but filled out the state version of the STAI after arrival at the laboratory. In addition, questions regarding compliance with behavioral restrictions before saliva collection and the dominance scale from the International Personality Item Pool (Goldberg et al. 2006, scale representing the California Psychological Inventory: http://ipip.ori.org/newCPIKey.htm#Dominance) were administered at the end of the experiment to avoid raising suspicion about the real purpose of the posture manipulation.

Saliva collection. We collected three saliva samples (1ml each) per participant using small tubes and stored them below -20°C immediately after collection. After completion of the study (duration: 51 days), they were packed in dry ice and shipped to the laboratory of Clemens Kirschbaum in Dresden, where they were analyzed with commercially available chemiluminescence immunoassays with high sensitivity (IBL International, Hamburg, Germany). For a more detailed description of the assay methods used by this laboratory, see for example Ronay et al. (2016). To exclude the possible influence of external factors on hormone levels, participants were requested to refrain from drinking alcohol and exercising intensively within 24 hours before the session, from smoking or taking medical drugs on the testing day, and from eating, drinking anything except water, and tooth brushing 1.5 hours before the session. The debriefing questionnaire after the experiment showed that they largely complied with these instructions (5 exceptions for alcohol, 2 for smoking).

Procedure

All testing sessions took place between 13h and 19h to attenuate effects of diurnal variation of hormone levels. Upon arrival, participants signed consent forms and completed the STAI state questionnaire. Participants were part of a larger sample taking part in a study on mental representations of in- and outgroup faces (Metzler, unpublished data). We used a well-established “number estimation style” procedure to induce minimal group membership, assigning participants to either the group of over- or under-estimators. Next, participant’s task was to guess, based on their first impression, which of two presented faces was an over- or under-estimator (Ratner et al., 2014). The cover story for collecting saliva samples consisted in telling participants that we were interested in the physiological makers associated with the tendency to over- or underestimate numbers. The cover story for the postures was that a second, unrelated project on the impact of body posture on heart rate was conducted simultaneously. At this point of the instructions, approximately 15 min after arrival, participants provided a first saliva sample.

Thereafter, the female experimenter determined the posture condition using a randomizing function and provided corresponding instructions for either the expansive (n=42) or the constrictive (n=40) posture. Participants would adopt this posture three times for 2 min each time in between the blocks of the face categorization task. This supposedly served to acquire heart-rate data for a total of 6 min while avoiding discomfort from holding the same posture for too long, and offered breaks during the visually demanding task (see Dotsch & Todorov, 2012 for an example of the noisy stimuli used for reverse correlation of mental representations). The experimenter placed electrodes on participant’s wrists and hooked them up to the acquisition system, which she demonstratively turned on afterwards. She verbally provided instructions on how to place each body part without demonstrating the posture herself. The expansive and constrictive posture involved open or closed limbs, erect or slumped upper body and straight or downward head tilt, respectively. The experimenter informed participants that she would check whether they correctly adopted the standing posture each time via a camera. Depending on the participant’s posture condition, she finally instructed participants to (1) sit upright with feet apart or (2) keep back and shoulders slumped and legs parallel or crossed during the task as far as comfortable for them, which supposedly served to “stabilize” the effect of postures on heart rate. This short instruction was repeated on screen at the beginning of each task block. Although allowing participants to freely adjust their posture for their own comfort during the task constitutes a less controlled posture manipulation, it ensures higher ecological validity, as it corresponds to what we typically do in everyday life. Participants were alone while they adopted the postures and performed the task. The experimenter only briefly re-entered the room for the collection of two more saliva samples.

In total, participants thus adopted the standing posture three times, i.e., before task block 1, 3 and 5. Saliva samples were collected before the first posture and block and after block 4 and 6. Participants had thus adopted the posture twice before sample 2, and three times before sample 3. Median block duration was 4.58 minutes (interquartile range [3.46-6.25]) depending on participants’ speed in the face categorization task. This resulted in collection of saliva samples 2 and 3 approximately 23 and 36 minutes after the first posture, respectively, although the exact timing varied between participants (min. 14 minutes, max. 50). This corresponds to collection of samples 2 and 3 approximately 11 and 24 minutes after the second posture, respectively, and collection of sample 3 approximately 10 minutes after the third posture. Figure 1A and B depict the timing of postures and saliva samples, and Figure 1C depicts the posture adopted in each of the two experimental groups.

At the end of the experiment, participants were carefully debriefed regarding suspicions about the postures. None of them had suspected a link between the posture manipulation and the saliva samples and only one participant raised doubts about our interest in a posture effect on heart-rate. Excluding him from analyses did not affect the results.

Data analysis

Outliers were determined per time point using a conservative threshold of three times the absolute deviation from the median (Leys et al., 2013), given that mean ± SD rules are problematic for endocrine data which are rarely normally distributed (Pollet & Meij, 2017). First, we excluded one participant from all time points and hormones due to extreme progesterone values (around 1500pg/ml, (outside of normal range even for women, see Liening et al., 2010), clearly indicating a problem with his salivary samples. Within the remaining sample of 81 participants (age 21.36 ± 2.78, expansive n=41, constrictive n=40), there were six outliers above the median plus three absolute deviations for cortisol, seven for testosterone and nine for progesterone. Results calculated without outliers did not differ from results with the full sample (see Supplementary Table S1), i.e., the same effects yielded significant or non-significant p-values with and without outlier exclusion. All hormone levels were log-transformed to correct for right-skewed distributions and subjected to a mixed-effects ANOVA with posture (expansive, constrictive) as a between-subject and time (T1, T2, T3) as a within-subject factor. In addition to partial eta-squared, we report generalized eta-squared as an effect-size to allow for comparison with between-subject designs (Lakens, 2013). All analysis were done in R (R Core Team, 2018) using the packages ez, psych, latticeExtra, ggplot2 and dplyr (Wickham, 2009; Lawrence, 2016; Sarkar & Andrews, 2016; Revelle, 2017; Wickham et al., 2017). Data and analysis scripts are available at https://osf.io/3nrsy/.

Results

Descriptive statistics for raw levels of cortisol, testosterone and progesterone are presented in Table 1, and results are depicted in Fig. 2.

Cortisol

Cortisol levels similarly decreased over time ($F(2,148)=79.40$, $p<.001$, $\eta^2_p = 0.51$, $\eta^2_G= 0.16$) in both posture groups (time*posture: $F(2,148)=1.17$, $p=.313$, $\eta^2_p = 0.00$, $\eta^2_G= 0.00$), in the absence of any overall difference between the groups ($F(1,74)=0.32$, $p=.576$, $\eta^2_p = 0.00$, $\eta^2_G= 0.00$). Both the decrease from T1 to T2, i.e. from before the first posture to after adopting the posture twice, and the decrease from T2 to T3, i.e. from after the first two postures to after the third posture, were significant (T1-T2: $t(75)=-10.67$, $p<.001$, $d_z=-1.22$), T2-T3: $t(75)=-3.78$, $p<.001$, $d_z=-.43$). Cortisol baseline levels at T1 did not significantly differ between postures $t(74)=0.95$, $p = 0.346$).

Testosterone

Levels of testosterone also decreased throughout the experiment ($F(2,146)=19.76$, $p<.001$, $\eta^2_p = 0.21$, $\eta^2_G= 0.03$) with no different changes as a function of posture (time*posture: $F(2,146)= 1.09$, $p=.340$, $\eta^2_p = 0.01$, $\eta^2_G= 0.00$), and no main effect of posture ($F(1,73)=0.13$, $p=.721$, $\eta^2_p = 0.00$, $\eta^2_G= 0.00$). The decrease over time was significant from the first to the second ($t(74)=-$

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3.53, p=.001, d_z=-.41), as well as the second to the third time point (t(74)=-3.19, p=.002, d_z=-.37). Testosterone baseline levels did not differ significantly between the groups (t(73)=0.83, p=0.411).

Progesterone

As the two other hormones, progesterone levels declined over time (F(2,142)=33.07, p<.001, η^2_p = 0.32, η^2_G= 0.06) in the same manner in both posture groups (time*posture: F(2,142)=0.04, p=.965, η^2_p = 0.00, η^2_G= 0.00). There was no general difference between the two postures (F(1,71)=2.52, p=.117, η^2_p = 0.00, η^2_G= 0.03). Declines between both pairs of time points were significant (T1-T2: t(72)=-4.63, p<.001, d_z=-.54; T2-T3: t(72)=-3.92, p<.001, d_z=-.46). Progesterone baseline levels were not significantly different between the two postures (t(71)= 1.52, p = 0.132).

Self-report questionnaires

Participants from the two posture groups did not rate themselves as significantly different on self-esteem (t(77)= -0.73, p=.469, d=-0.08), trait anxiety (t(77)=0.02, p=.99, d=0.00), behavioral activation (t(77)=-0.15, p=.88, d=-0.02) and inhibition (t(77)=0.58, p=.562, d=0.07) prior to the testing day, nor on state anxiety at the beginning (t(79)=0.40, p=.689, d=0.045) or trait dominance at the end of the experiment (t(79)=-0.90, p=.372, d=-0.10).

Discussion

The present experiment investigated whether adopting expansive and constrictive postures, associated with high and low social power, respectively, impacts on salivary levels of hormones related to power, stress and affiliation. Although there is currently more evidence against than for a posture effect on hormones, several factors have been raised as explanations for why initial findings of Carney et al. (2010) did not replicate. Our design met most of the conditions which Carney et al. (2015) suspected to be necessary for observing postural feedback effects: first, we assessed postural effects on hormones in a social context during a face categorization experiment, second, we used a cover story, third, the instructions were given by an experimenter, and fourth, participants adopted postures for maximum two minutes at a time. Moreover, following up on hypotheses raised by Cuddy et al. (2018) and Davis et al. (2017), we investigated the possibility that repeatedly holding postures over time (i.e. larger doses of posture) and/or assessing hormonal responses at longer time intervals than previous studies would induce hormonal changes.

Under these specific experimental conditions, neither testosterone and cortisol levels linked to dominance behaviors and stress reactions, nor progesterone levels related to affiliative tendencies, changed from before to after adopting expansive or constrictive postures. Salivary levels of testosterone, cortisol and progesterone declined from baseline to two later post-posture samples, and did so similarly in the expansive and constrictive posture group. The first post-posture sample captured the potential incremental effect of adopting a posture twice, at approximately 23 and 11 minutes before sample collection. The second post-posture sample reflected the effect of adopting the same posture three times, at approximately 36, 24, and 10 minutes before sample collection.

Akin to four previous studies using a single posture manipulation (Ranehill et al., 2015; Ronay et al., 2016; Smith & Apicella, 2017; Davis et al., 2017), we did not replicate the effects reported by Carney et al. (2010), and thereby add to the evidence against an effect of postures on testosterone and cortisol levels. Our results demonstrate that even repeated adoption of expansive and constrictive postures while providing a cover story and a social context, each time for a short period of time to avoid discomfort, does not trigger hormonal changes. Thus, all the experimental characteristics listed by Carney et al. (2015) as possible reasons for null-results in Ranehill et al.'s replication (2015) were respected in the present study. An insufficient dose of posture as well as the collection of hormone samples at inappropriate time points after the posture manipulation (see Davis et al., 2017) therefore seem unlikely explanations for previous non-replications. The time points at which we collected saliva samples after onset of the first posture fell into the time window (20 to 40 minutes) in which experimentally induced cortisol responses are strongest (Dickerson & Kemeny, 2004). Testosterone and progesterone responses to arousal of power and affiliation motives have been observed in a similar time window (e.g. Schultheiss, Wirth & Stanton, 2004; Seidel et al., 2013). Still, our study shows together with previous non-replications that power postures do not elicit physiological changes associated with the experience of power and stress or the need for affiliation (Mehta & Josephs, 2011; Wirth, 2011; Schultheiss, 2013).

Three methodological differences with previous studies merit a more detailed discussion: First, we collected three samples in total in contrast to two in all previous studies, both with a longer delay after the onset of the first posture manipulation. This procedure revealed a decline from the first to the last time point for all three hormones. This decline may either simply reflect the diurnal pattern of these hormones (Faiman & Winter, 1971; Delfs et al., 1994; Brambilla et al., 2009; Liening et al., 2010), and/or a reduction in arousal from the start to the end of the experiment as far as cortisol is concerned. Second, we examined an exclusively male sample, whereas previous studies included mostly women (with the exception of Smith & Apicella, 2016). If anything, this reduced variation of our dependent variables and should hence have facilitated the detection of posture effects. Moreover, in the initial study (Carney, Cuddy & Yap, 2010) and one of its replications (Ranehill et al., 2015), effects on testosterone and feelings of power were stronger in men than in women (see Credé & Phillips, 2017). Nevertheless, we did not observe any effect in an exclusively male sample. Third, and this is a potential limitation of our study, hormone samples were not collected at exactly the same time points for all participants as in previous studies, but after participants had finished a fixed number of blocks from the face categorization task at their own speed. Yet, the distribution of sampling time points was very similar in both posture groups and all samples were collected in a time window in which hormonal responses generally occur (Dickerson & Kemeny, 2004; Schultheiss et al., 2012).

Conclusions

The current study assessed whether repeatedly adopting expansive and constrictive postures known as power postures induces endocrine responses that resemble the hormonal correlates of dominance and affiliative behavior. In doing so, it assessed whether larger doses of posture or collection of saliva samples at longer time intervals than previous studies would produce similar findings as the study by Carney et al. (2010) in contrast to previous non-replications. Participants adopted an expansive or constrictive posture three times for two minutes each, in between the blocks of a face categorization task. Salivary testosterone, cortisol and progesterone levels did not differ between posture groups within a time window of 14 to 50 minutes from the beginning of the first posture. Together with results from four previous non-replications, our study thus suggests that it is unlikely that short-term manipulations of postural expansiveness and constrictiveness elicit hormonal responses, even when postures are adopted repeatedly and within social contexts. While effects on other outcome variables described as promising by Cuddy et al. (2018) might be reproducible, the available evidence against an effect on hormone samples begins to clearly outweigh evidence for such an effect.

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Figure 1(on next page)

Time course of the experiment and adopted body postures.

A) Time course of posture, saliva sample and task blocks. **B)** Time intervals between postures and saliva samples from the beginning of posture 1 on. **C)** Postures adopted by each of the experimental groups (Images created by Antoine Balouka-Chadwick).

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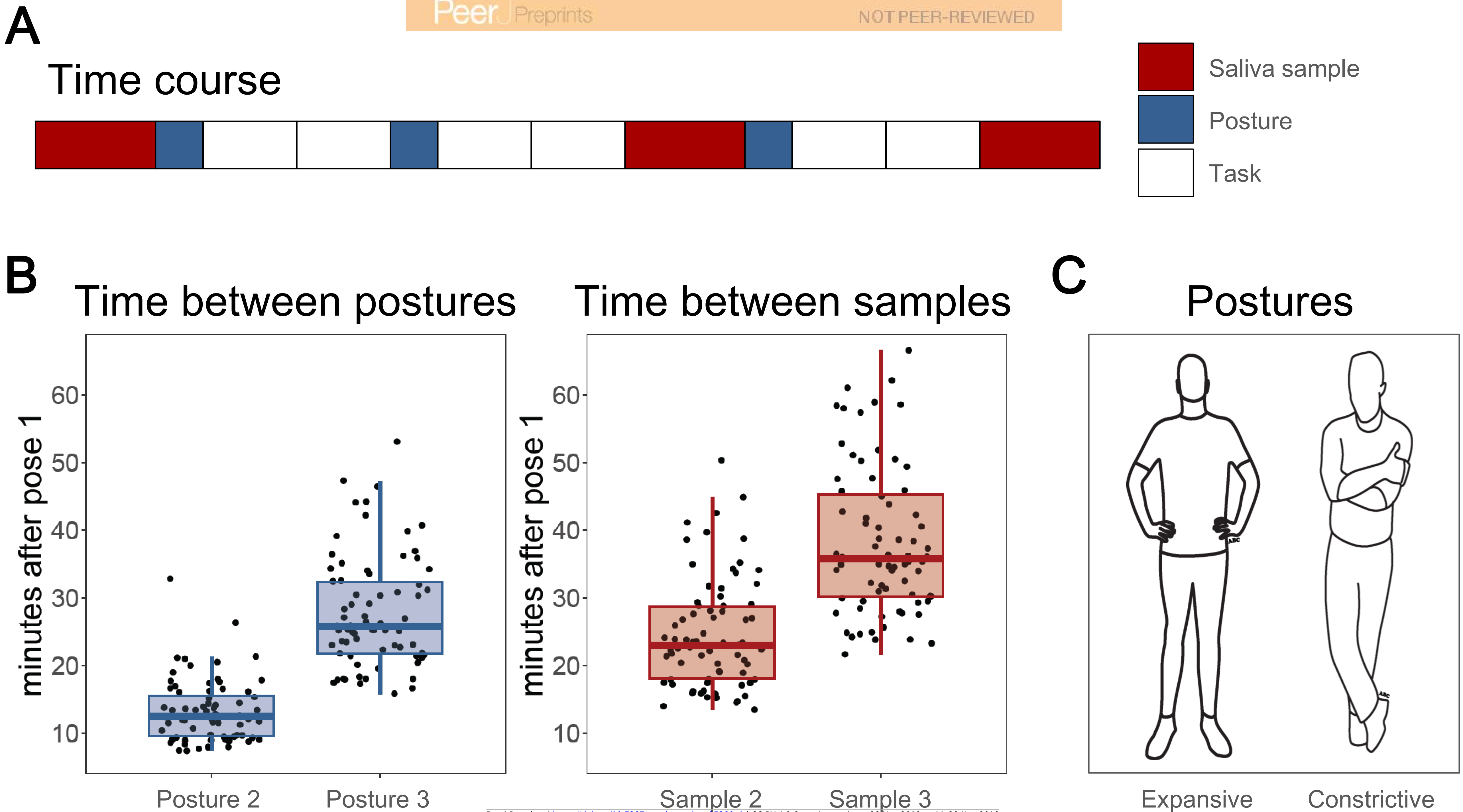
A
Time course
Saliva sample
Posture
Task
B
Time between postures
Time between samples
minutes after pose 1
60
50
40
30
20
10
Posture 2
Posture 3
Sample 2
Sample 3
C
Postures
Expansive
Constrictive

Figure 2(on next page)

Changes in hormone levels from before to after the posture manipulation.

Means, between-subject confidence intervals and individual data points for cortisol, testosterone and progesterone samples in pg/ml. Sample 1 was collected before the first posture. Sample 2 and 3 reflect the effect of adopting the same posture twice and three times, respectively. Asterisks indicate significance in t-tests between time points at *** = $p<.001$ and ** $p<.01$.

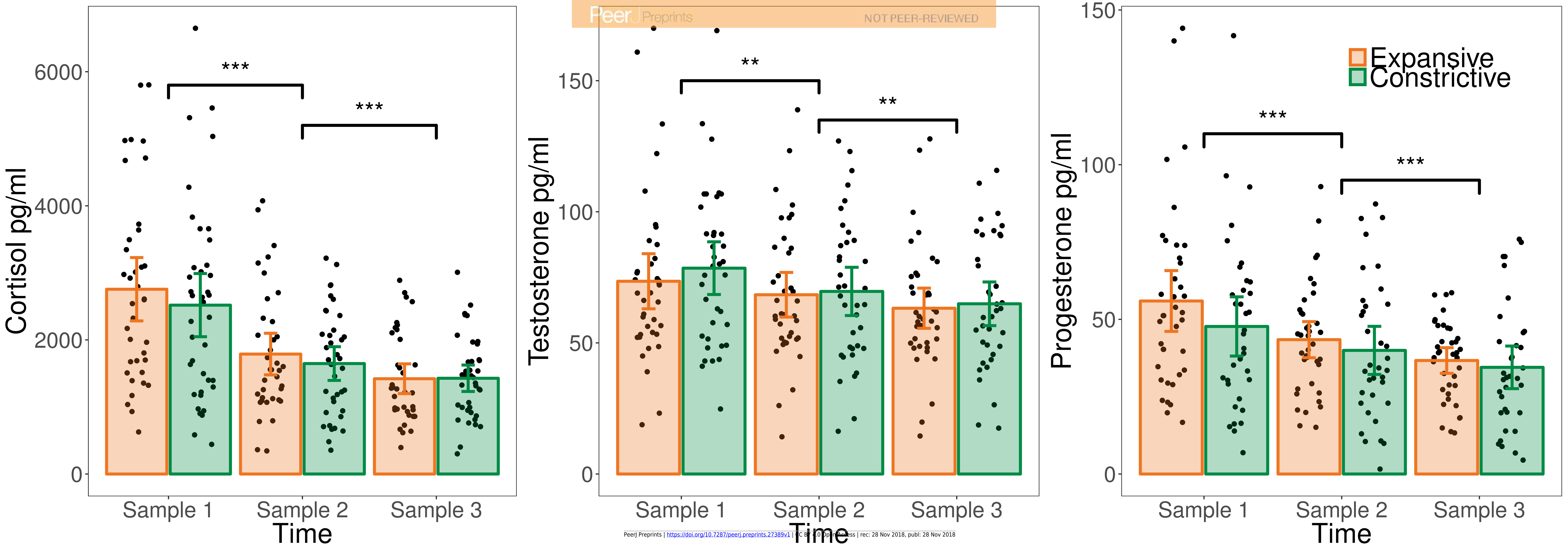
Cortisol pg/ml
0
2000
4000
6000
***
***
Sample 1
Sample 2
Sample 3
Time
Testosterone pg/ml
0
50
100
150
**
**
Sample 1
Sample 2
Sample 3
Time
Progesterone pg/ml
0
50
100
150
***
***
Expansive
Constrictive
Sample 1
Sample 2
Sample 3
Time

Table 1(on next page)

Descriptive statistics for cortisol, testosterone and progesterone in samples without outliers.

Confidence intervals are between-subject to allow for between-posture comparisons.

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	Posture	N	Sample	Mean	Median	SD	95% CI	
Cortisol pg/ml	Expansive	37	1	2755,88	2599,13	1416,89	2299,33	3212,44
			2	1788,89	1555,13	930,94	1488,92	2088,86
			3	1421,20	1268,75	665,40	1206,79	1635,60
	Constrictive	39	1	2518,72	2562,88	1453,86	2062,43	2975,02
			2	1647,33	1638,50	775,28	1404,01	1890,65
			3	1428,06	1439,13	608,28	1237,16	1618,97
Testosterone pg/ml	Expansive	38	1	73,52	69,05	31,96	63,35	83,68
			2	68,37	60,95	25,90	60,13	76,60
			3	63,23	59,60	23,32	55,81	70,64
	Constrictive	37	1	78,51	79,30	30,14	68,79	88,22
			2	69,64	67,90	27,59	60,74	78,53
			3	64,92	62,30	24,97	56,87	72,96
Progesterone pg/ml	Expansive	38	1	55,93	51,20	29,89	46,42	65,43
			2	43,43	43,35	17,76	37,79	49,08
			3	36,69	38,95	12,59	32,69	40,70
	Constrictive	35	1	47,70	45,30	27,87	38,47	56,94
			2	39,97	34,30	22,63	32,47	47,46
			3	34,49	31,20	20,05	27,84	41,13

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