https://doi.org/10.1007/s12144-020-01255-5

# Associations of Chinese social face with cortisol level and glucocorticoid receptor gene

Pingyuan Gong[1,2,3] · Wenxuan Guo[1] · Xia Zhang[1] · Keqing Cao[1] · Quanhe Wang[1] · Mengfei Zhang[1] · Jinting Liu[4] · Yuhe Fan[1] · Rui Zhang[1] · Xiaolin Zhou[5,6,7]

Accepted: 3 December 2020


**Abstract**
A major source of social stress in the Chinese society is losing face. Inspired by the roles of cortisol functions in stress-coping, we investigated whether cortisol functions (e.g., cortisol level and glucocorticoid receptor gene) are related to social face in Chinese. Study 1 examined the association between salivary cortisol level and social face among 134 college students; and Study 2 investigated associations between the polymorphisms (i.e., rs41423247 and rs10052957) of glucocorticoid receptor gene *(NR3C1)* and social face among 688 college students. Results from Study 1 indicated that salivary cortisol level was positively correlated to the scores on social face; and results from Study 2 showed that the GG genotype of rs41423247, which is related to higher receptor expression, was related to higher social face score as compared with the C allele. Moreover, the association between rs41423247 and social face was mediated by public self-consciousness. These findings highlight the importance of cortisol functions to social face and demonstrate a link between genetic polymorphism, social face and public self-consciousness.

**Keywords** Social face · Public self-consciousness · Cortisol · Glucocorticoid receptor

## Introduction

Social face (i.e., *mianzi* in Mandarin Chinese) refers to the public image that individuals want to project to others (Brown, 1987). As an old Chinese saying goes "*People live for their faces (honor) as trees live with their barks*", social face is involved in diverse social behaviors (Ho, Fu, & Ng, 2004). At the individual level, social face greatly enhances one's attainment and social standing, but may also lead to concealing one's44.642025993607(le)12.8(w)207999knes259930.6

✉ Pingyuan Gong
gpy1026@163.com

✉ Xiaolin Zhou
xz104@pku.edu.cn

1 College of Life Science, Northwest University, Xi'an 710069, China

2 College of Medicine, Northwest University, Xi'an 710069, China

3 Institute of Population and Health, Northwest University, Xi'an 710069, China

4 Research Center of Brain Function and Psychological Science, Shenzhen University, Shenzhen 518060, China

5 School of Psychology and Cognitive Science, East China Normal University, Shanghai 200062, China

6 School of Psychological and Cognitive Sciences, Peking University, Beijing 100871, China

7 PKU/McGovern Institute of Brain Research, Peking University, Beijing 100871, China

's biological predispositions.

Managing social face such as gaining face and avoiding losing face is a kind of stress. According to the face-negotiation theory (Ting-Toomey & Kurogi, 1998), desiring for social face is human's basic social need. When individuals' performance falls below the minimally acceptable level, they would show strong negative emotional responses such as depression and anxiety (Dong et al., 2013; Ho et al., 2004; Kam & Bond, 2011; Mosquera, Manstead, & Fischer, 2002; Braje & Hall, 2016). For instance, fearing losing face can intensify one's distress about being negatively evaluated by others (Mak & Xiaohua, 2006); negative experiences

involving losing social face such as at the receiving end of discrimination and stigmas can lead to psychological distress (Hackett, Steptoe, Lang, & Jackson, 2020; Le, Iwamoto, & Burke, 2020).

Studies have shown that cortisol functions (a term that we use here to refer to cortisol level and glucocorticoid receptor gene) are involved in coping with social face-related stress. Social-evaluative threat, as measured with the Trier Social Stress Test, can significantly elevate one's cortisol level (Dahm et al., 2017; Reschke-Hernandez, Okerstrom, Bowles Edwards, & Tranel, 2017; Turan, Tackett, Lechtreck, & Browning, 2015; Woody, Hooker, Zoccola, & Dickerson, 2018). Moreover, shame emerged from discriminating against one's creativity (Matheson & Anisman, 2009) and social anxiety of public speaking can increase cortisol reactivity (Auer, Calvi, Jordan, Schrader, & Byrd-Craven, 2018; Losiak, Blaut, Klosowska, & Slowik, 2016), and vice versa, the pronounced cortisol reactivity brings out negative emotions (Hellman, Morris, Rao, & Garber, 2015; Kiel & Kalomiris, 2016). Of note, although the past experiences of discrimination are related to cortisol reactivity (Busse, Yim, & Campos, 2017; Doyle & Molix, 2017; DuBois, Powers, Everett, & Juster, 2017; Jackson, Kirschbaum, & Steptoe, 2016; Jackson & Steptoe, 2018), it remains unclear whether cortisol functions are associated with social face.

Cortisol reactivity is greatly regulated by glucocorticoid receptor (McKlveen et al., 2013; Romeo, 2015; Vindas et al., 2017). When cortisol molecules bind to glucocorticoid receptor, glucocorticoid-receptor complex regulates the expressions of anti-inflammatory proteins and pro-inflammatory proteins (Bamberger, Bamberger, Castro, & Chrousos, 1995; Turk & John, 2005). The functions of glucocorticoid receptor are modulated by the polymorphisms in glucocorticoid receptor (*NR3C1*) gene (Kumsta et al., 2008; Plieger, Felten, Splittgerber, Duke, & Reuter, 2018). For instance, the G allele of rs41423247 is related to higher receptor expression and cortisol reactivity than the CC homozygous (Schote et al., 2019; Velders et al., 2012), so the AA genotype of rs10052957 is related to higher expression as compared with the AG/GG genotypes (Rosmond et al., 2000; Sinclair, Fullerton, Webster, & Shannon Weickert, 2012). The two polymorphisms are associated with cortisol reactivity in the context of social stress (Plieger, Felten, Splittgerber, Duke, & Reuter, 2018; Chen, Wang, & Lian, 2015; Nie et al., 2017; Shu, Wang, & Wang, 2016; Zhou et al., 2017). Given these backgrounds, the current study investigates the associations between the polymorphisms of rs41423247 and rs10052957 and social face.

Social face is related to public self-consciousness (Zhang, Cao, & Grigoriou, 2011), a general awareness of viewing oneself as a social object in other's eyes. Social face highlights individuals' desire for projecting their own good social images to others (Brown, 1987), while public self-consciousness reflects the self-directed attention to one's own external aspects (Davies, 1996). Studies have indicated that public self-consciousness can motivate face-saving behaviors such as concealing weakness and avoiding negative evaluation (Cho, Matsumoto, & Kimura, 2009; Shin, 2013; White, Stackhouse, & Argo, 2018). According to the self-presentation model (Schlenker & Leary, 1982), high public self-consciousness promotes one's attempts to manage self-impression such as gaining face and avoiding losing face. Indeed, studies indicated that public self-consciousness is associated with fearing losing face (Young, 2014; Zhang et al., 2011). Moreover, public self-consciousness such as stigma and losing dominance is related to increased cortisol reactivity (Doyle & Molix, 2017; Wirth, Welsh, & Schultheiss, 2006). In the current study, we examine whether the potential association between the *NR3C1* and social face is mediated by public self-consciousness.

In the Chinese culture, college students are considered as social elites with a respectable public image. They are sensitive to any distortion of social face. This research investigates the correlation between social face and salivary cortisol level in a student sample in Study 1 and the associations between the *NR3C1* polymorphisms and social face in another sample in Study 2. Basing on the correlation between cortisol level and psychological stress (Denson, Spanovic, & Miller, 2009), and the roles of rs41423247 and rs10052957 in the receptor expression (Rosmond et al., 2000; Sinclair, Fullerton, Webster, & Shannon Weickert, 2012; Schote et al., 2019; Velders et al., 2012), we predicted that both high cortisol level and high functional alleles (i.e., the G allele of rs41423247 and the A allele of rs10052957) are associated with high concern for social face and that the associations between such polymorphisms and social face are mediated by public self-consciousness.

## Sᵢd 1: The Correlaᵢion Beᵢ een Social Face and Corᵢisol Le el

### Methods

#### Participants

The power analysis suggested that 123 participants are required (two-tailed $\alpha = 0.05$, $1\text{-}\beta = 0.80$) if the effect size ($\rho$) reaches 0.25 (Sampath et al., 2017). Here, we recruited 3

Inventory (Cheung et al., 1996, 2010). The Face Scale consists of 11 items (Supplementary Materials 1) that measure the psychometric properties of desire to gain social face or avoid being involved in situations of losing face. For each item, the respondent scored on a 5-point Likert scale ("1" = extremely disagree and "5" = extremely agree) with the statement. The pencil-and-paper forma had the Cronbach's $\alpha$ of 0.73, which is similar to what reported previously ($\alpha = 0.72$ in Fan et al., 2008; $\alpha = 0.61$ in Ng et al., 2012).

### Salivary Cortisol Measurement

The college students participated in the study between 1:30 to 2:00 p.m. (Maruyama et al., 2012). Basing on Granger's suggestion (1999), we collected the saliva. The cortisol level was assessed with a commercial enzyme-linked immunosorbent assay kit (Cloud-Clone Corp., China). The optical densities of the mixtures in plate were read with a micro-plate reader (BioRad: iMARK) at wave-length of 450 nm and 630 nm. The standard curve was created with 4-parameter Logistic method. Details of measurement are shown in Supplementary Materials 1. The intra-assay coefficient of variability was less than 10%, and inter-assay coefficient of variability was less than 12%.

### Statistical Analysis

Statistical power was tested with the G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). The distributions of the cortisol level and score on social face were evaluated with Shapiro-Wilk tests. The correlation between cortisol level and social face score was examined with linear regression analysis on SPSS 18.0 software (SPSS Inc., Chicago, IL, USA). The significance was considered at $p < 0.05$ (two-tailed level).

## Results

Shapiro-Wilk test indicated that the score on social face scale was normally distributed (Mean ± SD = 34.20 ± 5.91), statistic = 0.99, $p = 0.18$, while the cortisol level significantly deviated from normal distribution (Mean ± SD = 30.76 ± 26.18 ng/mL), statistic = 0.59, $p < 0.001$. Following previous studies (Gerritsen et al., 2010; Martinez-Aguayo et al., 2012; Slopen et al., 2018), we transformed the cortisol level into natural-log values (0.86–2.42). The subsequent regression analysis showed that the transformed cortisol level was positively related to the score on social face, $\beta = 0.18$, $R^2 = 0.03$, $t(133) = 2.12$, $p = 0.04$.

## Study 2: The Association Between the *NR3C1* and Social Face

## Methods

### Participants

The power analysis suggested that a sample of 642 participants would be required (two-tailed $\alpha = 0.05$, 1-$\beta = 0.80$) if the effect size reaches 0.12 (i.e., partial $\eta^2 = 0.015$). We recruited 688 college students (65.84% female, mean age = 19.37 ± 1.52 years) from Henan University of Science and Technology, China. This study was approved by the Ethics Committee of Life Science College, Northwest University, China.

### Social Face Assessment

Social face was assessed with the Face Scale (Cheung et al., 1996, 2010). The scoring procedures were the same as in Study 1. Participants were tested in groups of 15–20. The Cronbach's $\alpha$ of this test was 0.71.

### Public Self-Consciousness Assessment

Public self-consciousness was measured with the 7-item Public Self-Consciousness Subscale of the Chinese version of the Self-Consciousness Scale (Fenigstein et al., 1975; Jiang, 2007). This instrument is reliable for assessing public self-consciousness, with a test-retest correlation of 0.84 in a 2-week interval (Fenigstein et al., 1975). This subscale measures the degree to which individuals are concerned about how others perceive them (e.g., "*I am concerned about the way I present myself*"). Response to each item was scored on a 5-point Likert scale, with "0" = strongly disagree and "4" = strongly agree with the statement. In the current study, the Cronbach's $\alpha$ was 0.72, approaching the values reported by Jiang ($\alpha = 0.71$, 2007) and Fenigstein ($\alpha = 0.84$, 1975).

### Genotyping

We extracted DNA from hair follicle cells with Chelex-100 method (de Lamballerie, Chapel, Vignoli, & Zandotti, 1994). The rs41423247 was amplified by polymerase chain reaction (PCR) with the upstream primer, 5′- ATGTTGACACCAAT TCCTCTCT − 3′, and downstream primer, 5′-TGCA

72 °C for 10 min. The PCR product was incubated with HinfI at 37 °C overnight. The digested mixtures were analyzed with 10% polyacrylamide gel electrophoresis. Similarly, the rs10052957 was amplified with upstream primer, 5′-GAAGGTGATGTATTCAGACTCG − 3′ and downstream primer 5′- GTAATGTATTTGTTGGGTGCC -3′. The G in upstream primer was a mutation for producing a restriction enzyme site for *Taq*I in PCR product. A 116 bp PCR product was amplified with an 5 min denaturation at 94 °C, followed by 35 cycles of 94 °C for 30 s, 60 °C for 30 s, 72 °C for 30 s, and a final extension at 72 °C for 10 min. The PCR product was incubated with *Taq*I at 65 °C overnight. Four participants were not successfully genotyped due to failure in DNA extracting. In this sample, neither rs41423247 (CC = 17, CG = 212, GG = 455; $\chi^2 = 1.761$, $p = 0.19$) nor rs10052957 (AA = 4, AG = 84, GG = 596; $\chi^2 = 0.305$, $p = 0.54$) deviated from the Hardy-Weinberg equilibrium.

### Statistical Analysis

Hardy-Weinberg equilibrium was tested with the FINETTI software (Sasieni, 1997). Statistical power was tested with the G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007). The questionnaire scores between the genotypes were examined with one-way ANOVA. To examine the genetic effects on social face when demographic variables were controlled, we conducted hierarchical regression analysis. The mediation effect size was tested with the SPSS version of the INDIRECT macro (Preacher & Hayes, 2008), a practice for assessing the statistical power in mediation models (Zhang, 2014). The significance was considered at $p < 0.05$ in two-tailed tests.

## Results

### Direct Effect

**Social Face** One-way ANOVA showed that the rs41423247 was significantly associated with the scores on social face (Mean ± Se: GG vs.CG vs. CC = 33.68 ± 0.28 vs. 31.83 ± 0.41 vs. 33.47 ± 0.91), $F$ (2, 681) = 7.39, $p = 0.001$, partial $\eta^2 = 0.02$. To include a sufficient number of participants in each group, we collapsed the minor homozygotes and heterozygotes into one group. After the CC ($N = 17$) was pooled with the CG genotype ($N = 212$), the results also indicated that the GG genotype ($N = 455$) had higher scores on social face than the C allele carriers (Mean ± Se: GG vs. CG/GG = 33.68 ± 0.28 vs. 31.95 ± 0.38), $F$ (1, 682) = 13.51, $p < 0.001$, and partial $\eta^2 = 0.02$ (Fig. 1). Similar analyses showed that rs10052957 was not associated with social face, $F$ (2, 681) = 0.002, $p = 0.99$, partial $\eta^2 < 0.001$. After the AA ($N = 4$) was combined with the AG genotype ($N = 84$), test again showed no significant differences between the two groups (Mean ± Se: GG vs. AG/AA = 33.11 ± 0.24 vs. 33.15 ± 0.66), $F$ (1, 682) = 0.003, $p = 0.95$, partial $\eta^2 < 0.001$. By categorizing participants into four groups based on their genotypes of rs41423247 (GG vs. GC/CC) and rs10052957 (GG vs. AA/AG), we further tested the interaction between the two polymorphisms. Two-way ANOVA indicated that the two polymorphisms did not interact on the scores on social face, $F$ (1, 682) = 0.02, $p = 0.88$, partial $\eta^2 < 0.001$.

As shown in Table S 1 and Table S 2 of Supplementary Materials 2, social face score was correlated with socioeconomic status, family function, and psychosocial characteristics, but not with age and sex (553 participants finished all the assessments). To examine whether the effect of rs41423247 remained to be significant after controlling such variables that were significantly correlated with social face score, we conducted a series of hierarchical regression analyses. For the hierarchical regression analysis with one demographic variable, in Step 1, a demographic variable was entered, and in Step 2, the demographic variable and the genotypes (0 = GG, 1 = CC/CG) were added. For the hierarchical regression analysis with multi-demographic variables, in Step 1, the demographic variables were entered, and in Step 2, both demographic variables and genotypes were added. The results showed that the contribution of rs41423247 to the scores on social face was significant whether the variables were controlled one by one, $\beta \geq 0.12$, $t$ (553) ≥ 2.86, $p \leq 0.004$, or all at once, $\beta = 0.11$, adjusted $R^2 = 0.16$, $t$ (546) = 2.90, $p = 0.004$ (Table S 4 of Supplementary Materials).

**Public Self-Consciousness** One-way ANOVA showed that rs41423247 was significantly associated with public self-consciousness (Mean ± Se: GG vs. CG vs. CC = 18.46 ± 0.20 vs. 17.58 ± 0.30 vs. 19.18 ± 0.92), $F$ (2, 678) = 3.41, $p = 0.03$, $\eta^2 = 0.01$. After pooling the CC ($N = 17$) with CG genotype ($N = 210$), we found that the GG genotype ($N = 453$) had higher public self-consciousness scores than the CG/GG group (GG vs. CG/CC = 18.46 ± 0.20 vs. 17.70 ± 0.29), $F$ (1, 679) = 4.66, $p = 0.03$, partial $\eta^2 = 0.007$ (Fig. 1b). For rs10052957, one-way ANOVA did not find significant differences between the genotypes, $F$ (2, 678) = 0.40, $p = 0.67$, partial $\eta^2 = 0.001$. After combining the AA ($N = 4$) with AG genotype ($N = 82$), we did not find a significant difference between the GG ($N = 594$) and AG/AA group either (GG vs. AG/AA = 18.27 ± 0.18 vs. 17.83 ± 0.45), $F$ (1, 679) = 0.80, $p = 0.37$, partial $\eta^2 = 0.001$. As for the social face assessment, we further examined the interaction between rs41423247 (GG vs. CG/CC) and rs10052957 (GG vs. AG/AA) public self-consciousness scores. Again, no significant interaction was observed, $F$ (1, 679) = 2.28, $p = 0.13$, partial $\eta^2 = 0.003$.

As shown in Table S 5 of Supplementary Materials 2, public self-consciousness was significantly correlated with vari-

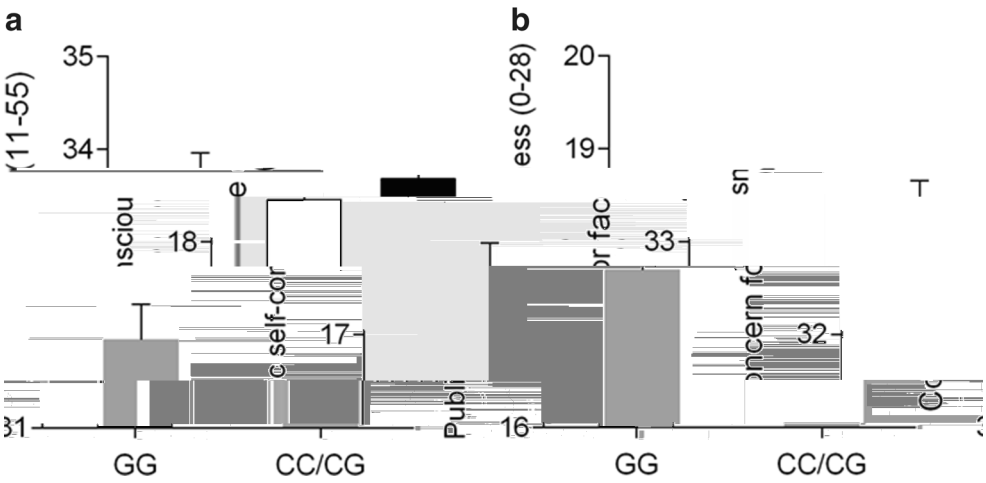


**Fig. 1** (**a**) The scores on social face of the GG ($N = 229$) and CG/CC ($N = 445$) of rs41423247 (GG vs. CC/CG = 33.68 ± 0.28 vs. 31.95 ± 0.38); (**b**) the scores on public self-consciousness of the GG ($N = 227$) and CG/CC ($N = 453$) of rs41423247 (GG vs. CC/CG = 18.46 ± 0.20 vs. 17.70 ± 0.29)

analysis showed a contribution of rs41423247 (0 = GG, 1 = GC/CC) to public self-consciousness when the variables were controlled one by one, $\beta \geq 0.12$, $t \geq 2.86$, $p \leq 0.004$, but the effect was marginal when all at once, $\beta = 0.07$, adjusted $R^2 = 0.06$, $t = 1.88$, $p = 0.06$ (Table S 6).

### Mediation Analysis

As previous studies indicated that public self-consciousness is positively correlated to social face (Cho, Matsumoto, & Kimura, 2009; Shin, 2013; White, Stackhouse, & Argo, 2018), we replicated this correlation, $r = 0.53$, $p < 0.001$. We conducted a mediation analysis with a pathway from public self-consciousness to social face. Of note, considering that rs10052957 was not significantly correlated with the social face and public self-consciousness scores, we excluded this polymorphism in analysis. A regression analysis with the genotypes of rs41423247 (0 = GG, 1 = CG/CC) as predictor showed a significant association between this polymorphism and social face, $\beta = 0.15$, $R^2 = 0.02$, $t$ (680) = 3.84, $p < 0.001$. When including both the genotypes and public self-consciousness, we found that the association remained significant, $\beta' = 0.10$, adjusted $R^2 = 0.29$, $t$ (680) = 3.17, $p = 0.002$. Of note, there was a significant difference between $\beta$ and $\beta'$, $F$ (1,679) = 188.99, $p < 0.001$, suggesting that the association was partly mediated by public self-consciousness. Moreover, bootstrapped test with 20,000 times (Preacher & Hayes, 2008) showed that the association was significantly mediated by public self-consciousness, $R$-squared mediation effect size = 0.01, SE = 0.007, 95% CI [0.001, 0.028]. The mediating effect, calculated with 1- (0.10/0.15), accounted for 29.45% of the genetic effect on social face score (Fig. 2). Furthermore, after socioeconomic status and psychosocial characteristics were controlled, the mediation was still significant, $R$-squared mediation effect size =1.03, SE = 0.38, 95% CI [0.28, 1.78], and accounting for 73.30% of the total effect.

## Discussion

This research examined the associations between social face and cortisol level and the *NR3C1* polymorphisms. Study 1 indicated that cortisol level is positively related to the scores on social face, and Study 2 indicated that the GG genotype of rs41423247 is related to higher scores on social face than the C carriers. The association between rs41423247 and social face is mediated by public self-consciousness. This research highlights the biopsychological pathway between cortisol functions and social face.

Previous studies showed that both discrimination and stigmas heighten one's cortisol reactivity (Busse, Yim, & Campos, 2017; Doyle & Molix, 2017; DuBois, Powers, Everett, & Juster, 2017; Jackson, Kirschbaum, & Steptoe, 2016; Jackson & Steptoe, 2018). These studies focused on the links between cortisol reactivity and past experiences of discrimination and stigmas. In contrast, this study found a relationship between cortisol level and social face of future events. Thus, the findings suggest that cortisol is involved not only in past experiences of losing face, but also in face-consciousness for future face-threatening events. Given that social face is the philosophy of Chinese daily lives, these findings provide evidence of cortisol functions in Chinese face-philosophy.

Glucocorticoid receptor is involved in stress-coping (McKlveen et al., 2013; Romeo, 2015; Vindas et al., 2017). Upon exposure to stress of losing face, the hypothalamus secretes corticotrophin-releasing hormone, which subquently promotes the releasing of cortisol (Romeo, 2015). When cortisol molecules bind to the glucocorticoid receptor, the glucocorticoid-receptor complex regulates the expressions of anti-inflammatory proteins and pro-inflammatory proteins (Bamberger, Bamberger, Castro, & Chrousos, 1995; Turk & John, 2005). The current study revealed that the GG genotype of rs41423247, which is related to high receptor expression and cortisol reactivity (Schote

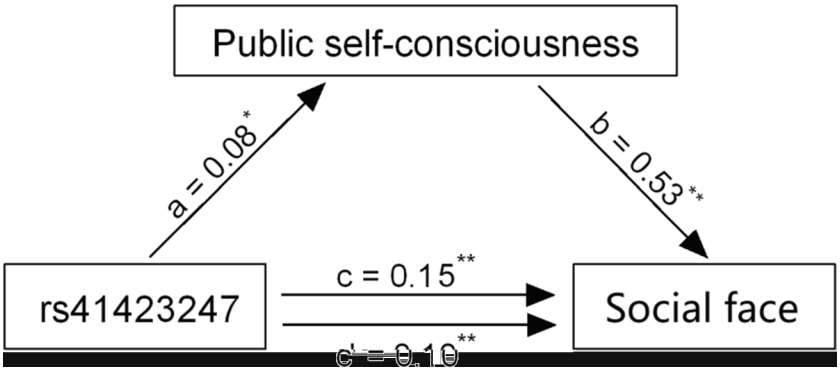


**Fig. 2** The mediation of

et al., 2019; Velders et al., 2012) and greater neural response in right dorsolateral prefrontal cortex in working memory tasks (El-Hage et al., 2013), is related to higher social face than the CG/CC group. The high expressed G allele possibly facilitates coping with face-related stress via inhibiting automatic goal-irrelevant information (Putman & Roelofs, 2011; Zuj, Palmer, Malhi, Bryant, & Felmingham, 2017). Thus, different from previous studies that address the influences of cultural contexts and socioeconomic resources on social face (Bedford & Hwang, 2013; Yuan & Bond, 2011), we provide new insights into the individual differences in social face at genetic level.

This study indicated that the GG genotype of rs41423247 is related to high public self-consciousness. Given that public self-consciousness and social face such as discrimination experience and stigmas are positively related to cortisol reactivity (Busse et al., 2017; Doyle & Molix, 2017; DuBois et al., 2017; Jackson et al., 2016; Jackson & Steptoe, 2018), the effects of cortisol on fear of negative evaluation are potential psychobiological foundation underlying this association between rs41423247 and public self-consciousness. Due to public self-consciousness mediates 73.30% of the effect of rs41423247 on social face, the findings provide new perspective on the link between public self-consciousness and social face the genetic level.

Different from prevoius studies investigating the influences of demographic characteristics on social face (He & Zhang, 2011; Huang & Wu, 2012), this study addresses the link between social face and genetic predisposition, as well as the influences of social contexts. More interestingly, we found that the influence of rs41423247 on social face remains to be significant when demographic variables were controlled. As compared with the acute effect of cortisol reactivity on social face in situational interactions (Dahm et al., 2017; Reschke-Hernandez et al., 2017; Turan et al., 2015; Woody et al., 2018), this genetic effect was more stable. Of note, we examined the associations between two functional polymorphisms and social face and did not find the significant association between rs10052957 and social face. The lack of significant association possibly is attributed to the low frequencies of the AA and AG genotypes. The extreme imbalance of the genotypes has reduced statistical power (Boks, Derks, Dolan, Kahn, & Ophoff, 2010; Konstantopoulos, 2010). Moreover, we found that the GG genotype of rs41423247 is related to higher cortisol level as compared with the CG/CC groups, while the relationship between cortisol level and the genotypes of rs10052957 is not significant (Table S 7 of Supplementary Materials 3), which can also explain the lack of the assocation between rs1005257 and social face.

Several limitations should be mentioned. First, the participants did not generate income of their own, and their socioeconomic status was largely dependent on the supports from families. Individuals living in a social context characterized by high social status were more suitable. Second, due to social face is highly influenced by cultural contexts, and this study only shows the relationships in Chinese culture, future studies should be conducted in West societies. Third, the Face-scale is one of the earliest scales for measuring social face. This scale caught our attention for well revision in Chinese. As more professional scales have appeared (Leong, Byrne, Hardin, Zhang, & Chong, 2018; Zhang, Cao, & Grigoriou, 2011), new tools should be used in future study. Finally, the relation between cortisol reactivity and social face was examined in a small sample, which reduced the interpretation of cortisol as a biomarker of social face. Future studies should be carried out in large samples.

## Concl sion

This study demonstrates the associations of cortisol level and *NR3C1* with social face and highlights the mediation of public self-consciousness in the association between social face and

*NR3C1* in Chinese culture. These findings suggest a practical application of cortisol for reducing social anxiety of losing face.

**Supplementary Information** The online version contains supplementary material available at https://doi.org/10.1007/s12144-020-01255-5.

**Author Contributions** All authors had full access to all the data. Performed the experiment: Pingyuan Gong, Wenxuan Guo, Xia Zhang, Keqing Cao, Quanhe Wang, Mengfei Zhang, Jinting Liu, Yuhe Fan, Rui Zhang. Analyzed the data: Pingyuan Gong. Wrote the paper: Pingyuan Gong and Xiaolin Zhou. Designed the study: Pingyuan Gong and Xiaolin Zhou.

**Funding** This study was supported by the Ministry of Education of Humanities and Social Science Foundation (19YJAZH021) and the National Social Science Fund of China (20BSH165) to Pingyuan Gong.

## Compliance with Ethical Standards

**Declaration of Conflicting Interests** The authors declared that they had no conflicts of interest with respect to the authorship or the publication of this article.

## References

Auer, B. J., Calvi, J. L., Jordan, N. M., Schrader, D., & Byrd-Craven, J. (2018). Communication and social interaction anxiety enhance interleukin-1 beta and cortisol reactivity during high-stakes public speaking. *Psychoneuroendocrinology, 94*, 83–90. https://doi.org/10.1016/j.psyneuen.2018.05.011.

Bamberger, C. M., Bamberger, A. M., De Castro, M., , & Chrousos, G. P. (1995). Glucocorticoid receptor beta, a potential endogenous inhibitor of glucocorticoid action in humans. Journal of Clinical Investigation, 95(6), 2435–2441. doi:https://doi.org/10.1172/JCI117943.

Barclay, P. (2012). Harnessing the power of reputation: Strengths and limits for promoting cooperative behaviors. *Evolutionary Psychology, 10*(5), 868–883. https://doi.org/10.1177/147470491201000509.

Bedford, O., & Hwang, S. L. (2013). Building relationships for business in Taiwanese hostess clubs: The psychological and social processes of guanxi development. *Gender, Work and Organization, 20*(3), 297–310. https://doi.org/10.1111/j.1468-0432.2011.00576.x.

Boks, M. P. M., Derks, E. M., Dolan, C. V., Kahn, R. S., & Ophoff, R. A. (2010). "Forward genetics" as a method to maximize power and cost-efficiency in studies of human complex traits. *Behavior Genetics, 40*(4), 564–571. https://doi.org/10.1007/s10519-010-9348-y.

Braje, S. E., & Hall, G. C. N. (2016). Coping as a mediator between losing face and depressive and social anxiety symptoms among Asian Americans. *Journal of Cross-Cultural Psychology, 47*(8), 1114–1129. https://doi.org/10.1177/0022022116658244.

Brown, P., & L. S. C. (1987). *Politeness: Some universals in language usage*. London: Cambrige University Press.

Busse, D., Yim, I. S., & Campos, B. (2017). Social context matters: Ethnicity, discrimination and stress reactivity. *Psychoneuroendocrinology, 83*, 187–193. https://doi.org/10.1016/j.psyneuen.2017.05.025.

Chen, Y. L., Wang, Q., & Lian, Y. L. (2015). Interactive effect of genetic and environmental factors on stress response susceptibility (in Chinese). *Chinese Journal of Public Health, 31*(12), 1660–1662. https://doi.org/10.11847/zgggws2015-31-12-40.

Cheung, F., Fan, W., & To, C. (2010). The Chinese personality assessment inventory as a culturally relevant personality measure in applied settings. *Social & Personality Psychology Compass, 3*(6), 1113–1119. https://doi.org/10.1111/j.1751-9004.2007.00045.x.

Cheung, F. M., Leung, K., Fan, R. M., Song, W. Z., Zhang, J. X., & Zhang, J. P. (1996). Development of the Chinese personality assessment inventory. *Journal of Cross-Cultural Psychology, 27*(2), 181–199. https://doi.org/10.1177/0022022196272003.

Cho, S., Matsumoto, Y., & Kimura, H. (2009). The moderating effect of self-esteem on the relationship between public self-consciousness, social anxiety and exhibitionism in Japan and South Korea (in Korean). *Shinrigaku Kenkyu: The Japanese Journal of Psychology, 80*(4), 313–320. https://doi.org/10.4992/jjpsy.80.313.

Dahm, A. S., Schmierer, P., Veer, I. M., Streit, F., Gorgen, A., Kruschwitz, J., et al. (2017). The burden of conscientiousness? Examining brain activation and cortisol response during social evaluative stress. *Psychoneuroendocrinology, 78*, 48–56. https://doi.org/10.1016/j.psyneuen.2017.01.019.

Davies, F. M. (1996). Self-consciousness and the complexity of private and public aspects of identity. *Social Behavior & Personality, 24*(2), 113–118. https://doi.org/10.2224/sbp.1996.24.2.113.

de Lamballerie, X., Chapel, F., Vignoli, C., & Zandotti, C. (1994). Improved current methods for amplification of DNA from routinely processed liver tissue by PCR. *Journal of Clinical Pathology, 47*(5), 466–467. https://doi.org/10.1136/jcp.47.5.466.

Denson, T. F., Spanovic, M., & Miller, N. (2009). Cognitive appraisals and emotions predict cortisol and immune responses: A meta-analysis of acute laboratory social stressors and emotion inductions. *Psychological Bulletin, 135*(6), 823–853. https://doi.org/10.1037/a0016909.

Dong, P., Huang, X., & Wyer, R. S. (2013). The illusion of saving face: How people symbolically cope with embarrassment. *Psychological Science, 24*(10), 2005–2012. https://doi.org/10.1177/0956797613482946.

Doyle, D. M., & Molix, L. (2017). Stigma consciousness modulates cortisol reactivity to social stress in women. *European Journal of Social Psychology, 48*(2), 217–224. https://doi.org/10.1002/ejsp.2310.

DuBois, L. Z., Powers, S., Everett, B. G., & Juster, R. P. (2017). Stigma and diurnal cortisol among transitioning transgender men. *Psychoneuroendocrinology, 82*, 59–66. https://doi.org/10.1016/j.psyneuen.2017.05.008.

El-Hage, W., Phillips, M. L., Radua, J., Gohier, B., Zelaya, F. O., Collier, D. A., & Surguladze, S. A. (2013). Genetic modulation of neural response during working memory in healthy individuals: Interaction of glucocorticoid receptor and dopaminergic genes. *Molecular Psychiatry, 18*(2), 174–182. https://doi.org/10.1038/mp.2011.145.

Fan, W. Q., Cheung, F. M., Cheung, S. F., & Kwok, L. (2008). Standardization of the cross-cultural Chinese personality assessment inventory for adolescents in Hong Kong: A combined emic -etic approach to personality assessment. *Acta Psychologica Sinica, 40*(7), 839–852.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G*power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191. https://doi.org/10.3758/BF03193146.

Fenigstein, A., Scheier, M., & Buss, A. (1975). Public and private selfconsciousness: Assessment and theory. *Journal of Consulting and Clinical Psychology, 43*, 522–527.

Gerritsen, L., Geerlings, M. I., Beekman, A. T., Deeg, D. J., Penninx, B. W., & Comijs, H. C. (2010). Early and late life events and salivary cortisol in older persons. *Psychological Medicine, 40*, 1569–1578. https://doi.org/10.1017/S0033291709991863.

Granger, D. A., Schwartz, E. B., Booth, A., Curran, M., & Zakaria, D. (1999). Assessing dehydroepiandrosterone in saliva: a simple radioimmunoassay for use in studies of children, adolescents and adults. *Psychoneuroendocrinology, 24*(5), 567–579. https://doi.org/10.1016/S0306-4530(99)00013-X.

Hackett, R. A., Steptoe, A., Lang, R. P., & Jackson, S. E. (2020). Disability discrimination and well-being in the United Kingdom: A prospective cohort study. *BMJ Open, 10*(3), e035714. https://doi.org/10.1136/bmjopen-2019-035714.

He, M., & Zhang, S. J. (2011). Re-conceptualizing the Chinese concept of face from a face-sensitive perspective: A case study of a modern Chinese TV drama. *Journal of Pragmatics, 43*(9), 2360–2372. https://doi.org/10.1016/j.pragma.2011.03.004.

Hellman, N., Morris, M. C., Rao, U., & Garber, J. (2015). Depression history as a moderator of relations between cortisol and shame responses to social-evaluative threat in young adults. *Biological Psychology, 109*, 159–165. https://doi.org/10.1016/j.biopsycho.2015.05.007.

*Neuroscience Research, 95*(1–2), 106–114. https://doi.org/10.1002/jnr.23851.

Romeo, R. D. (2015). Hypothalamic nuclear glucocorticoid receptors: Acute stress and rapid actions. *Endocrinology, 156*(8), 2747–2748. https://doi.org/10.1210/en.2015-1537.

Rosmond, R., Chagnon, Y. C., Chagnon, M., Pérusse, L., Bouchard, C., & Björntorp, P. (2000). A polymorphism of the 5′-flanking region of the glucocorticoid receptor gene locus is associated with basal cortisol secretion in men. *Metabolism-Clinical & Experimental, 49*(9), 1197–1199. https://doi.org/10.1053/meta.2000.7712.