Hierarchy Stability Moderates the Impact of Status on Stress and Performance in Humans

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Abstract:

High social status reduces stress responses in numerous species, but this stress-buffering effect of status may dissipate or even reverse during times of hierarchical instability. In a novel experimental test of this hypothesis, 118 participants (57.3% female) were randomly assigned to a high or low status position in a stable or unstable hierarchy and were then exposed to a social-evaluative stressor (a mock job interview). High status in a stable hierarchy buffered stress responses and improved interview performance, but high status in an unstable hierarchy boosted stress responses and did not lead to better performance. This general pattern of effects was observed across endocrine (cortisol and testosterone), psychological (feeling in control), and behavioral (competence, dominance, and warmth) responses to the stressor. The joint influence of status and hierarchy stability on interview performance was explained by feelings of control and testosterone reactivity. Greater feelings of control predicted enhanced interview performance, whereas increased testosterone reactivity predicted worse performance. These results provide direct causal evidence that high status confers adaptive benefits for stress reduction and performance only when the social hierarchy is stable. When the hierarchy is unstable, high status actually exacerbates stress responses.

Significance Statement:

High-status leadership roles are theorized to reduce stress compared to subordinate roles, but higher rank is not always stress free. Here we demonstrate that high status inhibits stress responses and improves performance during a mock interview in a stable hierarchy, but high status boosts stress responses and carries no performance advantage in an unstable hierarchy. Feeling in control was an asset for interview performance, but increased testosterone reactivity was a liability. These findings have applications for improving outcomes in stressful evaluative settings, such as job interviews, and may hold translational implications for the influence of status on health.

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Social status is robustly linked with health outcomes in most human societies. Individuals with higher socioeconomic status live longer, experience increased well-being, and have lower rates of stress-related diseases such as cardiovascular conditions and Type-II diabetes (1,2). These health benefits may be explained in part by the stress-buffering effects of status. High status inhibits responses to acute stressors (3-6), which reduces physiological wear-and-tear and the likelihood of developing stress-linked diseases (2,7). In further support of the hypothesis that status buffers stress, attaining high rank in a hierarchy – such as a leadership position – is related to reduced concentrations of basal cortisol, a hormone released as part of the hypothalamic-pituitary-adrenal (HPA) axis in response to psychological stress (8,9). Despite a growing scientific consensus that high status is related to lower stress in humans, this previous research has focused primarily on stable hierarchies. During times of hierarchical instability when status could change, we propose that high status might boost – not buffer – stress responses. After all, the threat of losing a powerful high-ranking position and the need to defend it may be stressful. Correlational work in nonhuman primates provides initial support for this perspective. In one seminal study of olive baboons (*Papio anubis*), high-ranking males had lower basal cortisol levels compared to low-ranking males when the hierarchy was stable. However, this effect reversed when the hierarchy was unstable; higher-ranking males had higher basal cortisol levels compared to lower-ranking males (10). Although this correlational evidence from primate research is promising, what we are deeming the *hierarchy instability hypothesis* – that an unstable hierarchy blocks or even reverses the effect of status on responses to acute stressors – is lacking a direct experimental test.

An experimental test of the hierarchy instability hypothesis in humans has public health implications because stress response systems such as the HPA axis impact immune function and overall health (2,7). Evidence in support of the hierarchy instability hypothesis could point to circumstances in which high status may lead to poor health and provide insight into the underlying mechanisms. Testing this hypothesis across multiple aspects of the stress response can further elucidate the consequences of acute stress responses for human behavior in both stable and unstable hierarchies, which to date remain largely unknown. Building on research in nonhuman primates, the present experiment tested the hierarchy instability hypothesis across key hormonal, psychological, and behavioral responses to a social-evaluative stressor.

We tested our hypothesis on cortisol responses to the stressor, but the hierarchy instability hypothesis may extend to testosterone as well. Testosterone is a sex hormone that is theorized to motivate concern for status (11). Thus, concentrations of this hormone may be especially likely to increase under conditions of status threat, such as when high status can be lost. In line with this theorizing, correlational research in nonhuman primates indicates that high-ranking positions in unstable hierarchies are associated with higher basal testosterone levels compared to low-ranking positions in unstable hierarchies, but higher rank is often unrelated to elevated basal testosterone levels in stable hierarchies (12, 13; cf. 14). Building on this primate research and our hierarchy instability hypothesis, we propose that the threat of losing status for a high-ranking individual in an unstable hierarchy may intensify status-relevant stress and stimulate the desire to protect one's status, leading to elevated testosterone responses to the social-evaluative stressor. In contrast, a high-ranking position in a stable hierarchy may lower status-relevant stress because status cannot be lost and does not require protection, leading to buffered testosterone reactivity to the stressor. Testing the joint influences of status and

hierarchy stability on cortisol and testosterone expands prior research on endocrine responses to social-evaluative stressors, which has primarily focused on cortisol as an index of stress and has paid surprisingly little attention to testosterone.

The hierarchy instability hypothesis may also predict behavioral responses to the stressor. Previous research has shown that priming high rank improves performance in social-evaluative situations such as mock job interviews, which leads to better outcomes (e.g., being hired for the job) (15,16). These positive social evaluations are influenced by status-relevant behaviors such as competence, dominance, and warmth (17,18). But again, the causal impact of status on performance in social-evaluative settings has only been tested in stable hierarchies. According to our hierarchy instability hypothesis, high status in a stable hierarchy should lead to positive performance evaluations compared to low status, but hierarchical instability should reduce or reverse these differences.

We also investigated the mechanisms through which status and hierarchy instability impact performance under stress. One likely psychological mechanism is through feeling in control. Powerful high-status positions are associated with greater feelings of control, and perceived control encourages status-relevant behaviors that boost performance evaluations (19-22). We extend this work by testing whether hierarchy instability blocks the influence of status on performance via reduced feelings of control. In addition to testing this psychological mechanism, we also examined possible endocrine mechanisms. Prior research on acute cortisol responses and performance outcomes in stressful contexts has yielded mixed results (e.g., decision making performance: 23-25), but the consequences of acute testosterone responses for performance under social-evaluative stress have been largely overlooked. There is indirect evidence that elevated basal testosterone concentrations in status-threatening situations (e.g., losing a competition) predicts hyper-vigilance to status cues and impaired cognitive performance (26-28). Extending this prior research to the present study, we explored whether acute cortisol or testosterone responses to the stressor explained the effects of status and hierarchy instability on social-evaluative performance.

To address these open questions regarding status, hierarchy stability, and stress responses, the present study experimentally manipulated status (high or low) and hierarchy stability (stable or unstable) prior to a social-evaluative stressor in a 2 x 2 between-subjects design. We employed the Trier Social Stress Test (TSST), a widely adopted stressor in which participants deliver a speech in front of evaluators that is akin to stressful situations found in professional settings such as job interviews (29,15,16). Fig. 1 shows the timeline of the study design. Participants reported their affective states (e.g., feeling in control) before and after the stressor and provided saliva samples at four time points to measure cortisol and testosterone reactivity and recovery to baseline following the stressor. Independent observers without knowledge of the study hypotheses or experimental manipulations later watched the videotaped speeches and rated participants on behavioral items that capture global performance evaluations (e.g., likelihood of hiring the candidate), competence, dominance, and warmth. We tested the hierarchy instability hypothesis across endocrine, psychological, and behavioral responses to the stressor. Finally, we conducted mediation analyses to investigate the mechanisms through which status and hierarchy stability influenced performance in the social-evaluative task.

Results

Preliminary analyses. For the analyses of endocrine change over time, cortisol and testosterone were natural-log-transformed to correct non-normal distributions; an arbitrary value of 10 was added to transformed cortisol values to ensure scores were positive for ease of interpretation (see SI appendix). We did not expect differences in baseline hormone concentrations as a function of experimental group because the baseline saliva samples were taken prior to random assignment to experimental conditions. Consistent with this expectation, general linear model (GLM) analyses revealed no main effects or interactions between experimental conditions on baseline cortisol or testosterone concentrations (ps > .05, η^2s < .035). Descriptive statistics and conditional means for the main dependent variables are shown in Tables S1 and S2 (SI Appendix).

Cortisol. To test the effects of status and hierarchy stability on cortisol responses to the stressor, we conducted a mixed-model GLM analysis with cortisol measurement time as a within-subject factor along with status and hierarchy stability as between-subjects factors. In agreement with our hierarchy instability hypothesis, there was a significant Status x Stability x Time interaction for cortisol ($F(1.82, 192.38) = 3.74$, $p = .029$, $\eta^2 = .034$)[1]. The overall pattern in Fig. 2 panel A suggests that higher status in a stable hierarchy buffered cortisol responses to the stressor – including blunted reactivity as well as declining cortisol concentrations during the recovery period. But higher status in an unstable hierarchy increased cortisol responses to the stressor – including enhanced reactivity as well as sustained elevation of cortisol concentrations during the recovery period.

To confirm this interpretation, we conducted separate GLM analyses for cortisol reactivity and recovery to baseline. Cortisol reactivity was calculated by subtracting baseline cortisol concentrations from cortisol concentrations measured immediately after the stressor. Cortisol recovery to baseline was calculated by subtracting baseline cortisol concentrations from cortisol concentrations measured forty minutes after the stressor. A positive recovery score indicates that cortisol levels were elevated above baseline levels forty minutes following the stressor.

In support of the hierarchy instability hypothesis, there were Status x Stability interactions on both cortisol reactivity ($F(1,106) = 4.82$, $p = .030$, $\eta^2 = .044$) and recovery ($F(1,106) = 6.58$, $p = .012$, $\eta^2 = .058$). As shown in Fig. 2 panel B, high-status individuals in an unstable hierarchy exhibited increased cortisol reactivity ($F(1,53) = 8.70$, $p = .005$, $\eta^2 = .141$) and increased cortisol recovery levels (i.e., recovery cortisol levels that remained above baseline; $F(1,53) = 10.56$, $p = .002$, $\eta^2 = .166$) compared to high-status individuals in a stable hierarchy. Low-status individuals in stable versus unstable hierarchies did not differ in their cortisol reactivity ($F(1,53) = 0.01$, $p = .94$, $\eta^2 < .001$) or recovery ($F(1,53) = 0.18$, $p = .673$, $\eta^2 = .003$). Consistent with theories proposing that high status should buffer stress responses in stable hierarchies, high status in a stable hierarchy also significantly reduced cortisol recovery levels compared to low status in a stable hierarchy ($F(1,54) = 4.90$, $p = .031$, $\eta^2 = .083$).

Taken together, these results provide direct empirical support for the hierarchy instability hypothesis across multiple indices of cortisol change. High-status individuals in a stable hierarchy showed blunted cortisol reactivity to the stressor and declining cortisol concentrations

[1]All mixed-model GLMs for endocrine activity are reported with appropriate Huynh-Feldt corrections. See SI Appendix method section for details.

during the recovery period. In contrast, high-status individuals in an unstable hierarchy showed increased cortisol reactivity to the stressor and cortisol concentrations that remained elevated over baseline levels during recovery.

Testosterone. To test the effects of status and hierarchy stability on testosterone responses, we conducted a mixed-model GLM analysis with testosterone measurement time as a within-subject factor, status and hierarchy stability as between-subjects factors, and participant sex as a covariate. This analysis revealed a significant Status x Stability x Time interaction for testosterone ($F(2.52, 264.70) = 4.42$, $p = .008$, $\eta^2 = .040$; see Fig 2 panel C). To interpret this interaction, we conducted follow-up GLM analyses on testosterone reactivity and recovery, calculated in the same fashion as the cortisol indices. Status x Stability interactions were found for both testosterone reactivity ($F(1,105) = 7.37$, $p = .008$, $\eta^2 = .066$) and recovery ($F(1,105) = 5.88$, $p = .017$, $\eta^2 = .053$). As shown in Fig. 2 Panel D, high status in an unstable hierarchy led to increased testosterone reactivity ($F(1,52) = 10.10$, $p = .002$, $\eta^2 = .163$) and increased testosterone recovery levels ($F(1,52) = 8.11$, $p = .006$, $\eta^2 = .135$) compared to high status in a stable hierarchy. Low-status individuals in stable versus unstable hierarchies did not differ in testosterone reactivity ($F(1,52) = 0.46$, $p = .502$, $\eta^2 = .009$) or recovery ($F(1,52) = 0.219$, $p = .642$, $\eta^2 = .004$).

High-status individuals in an unstable hierarchy also showed increased testosterone reactivity ($F(1,51) = 4.38$, $p = .041$, $\eta^2 = .079$) and increased testosterone recovery levels ($F(1,51) = 5.60$, $p = .022$, $\eta^2 = .099$) compared to low-status individuals in an unstable hierarchy. Collectively, these results generally align with the cortisol results and suggest that our hierarchy instability hypothesis applies not only to cortisol but to testosterone fluctuations in social-evaluative contexts as well.

Further analyses revealed that the interactions between status and hierarchy stability on endocrine responses (i) showed similar patterns when we adopted alternative strategies for analyzing cortisol and testosterone reactivity (SI Appendix, Tables S3 and S4, Fig. S1 and S2) as well as cortisol recovery (SI Appendix, Fig. S3); (ii) did not statistically differ between male and female participants (SI Appendix, Table S5); and (iii) were robust to additional covariates and to bootstrap bias correction (SI Appendix, Tables S6-8).

Feeling in Control. To test if our experimental manipulations influenced feeling in control, we conducted a mixed-model GLM analysis with time of measurement as a within-subjects factor along with Status and Hierarchy Stability as between-subjects factors. There was a non-significant Status x Stability x Time interaction ($F(1,103) = 0.001$, $p = .979$, $\eta^2 < .001$), but there was a statistically significant Status x Stability interaction in support of the hierarchy instability hypothesis ($F(1,103) = 4.72$, $p = .032$, $\eta^2 = .044$). Thus, our experimental manipulations modulated feeling in control starting after assignment to experimental conditions and remained after the stressor as well. To interpret the interaction, we averaged feeling in control scores measured before and after the stressor. As shown in Fig. 3 Panel A, high status boosted feeling in control scores compared to low status in the stable hierarchy ($F(1,53) = 9.45$, $p = .003$, $\eta^2 = .151$), but high and low status participants were indistinguishable in their feelings of control in the unstable hierarchy ($F(1,50) = 0.047$, $p = .830$, $\eta^2 = .001$). High-status individuals in a stable hierarchy also reported feeling more in control compared to high-status individuals in an unstable hierarchy ($F(1,52) = 5.47$, $p = .023$, $\eta^2 = .095$). Supplementary analyses revealed that status and hierarchy stability had non-significant effects on global measures of positive and negative affect (SI Appendix, Fig. S4). This pattern of results suggests

that status and hierarchy stability more robustly influence feeling in control compared to general positive and negative affect, which is consistent with theory linking perceived control to power and status (22).

Behavior During the Social-Evaluative Stressor. Videos of participants' speeches were rated on items that capture performance evaluations (e.g., Would you hire this individual?), competence, dominance, and warmth. Factor analysis indicated that three factors satisfactorily fit the data (SI Appendix, Table S9). In line with prior research indicating that appearing competent is a key driver of hiring decisions (17), performance ratings loaded onto the same factor as the competence items; two additional factors emerged for dominance and warmth. Subsequent analyses focused on interview performance (consisting of items that assess competence and performance), dominance, and warmth; models included sex as a covariate to account for potential sex differences in status-relevant behaviors (30).

In agreement with the hierarchy instability hypothesis, there was a significant Status x Stability interaction on interview performance ($F(1,104) = 4.86$, $p = .030$, $\eta^2 = .045$) (see Fig. 3 Panel B). In a stable hierarchy, high-status individuals performed better compared to low-status individuals ($F(1,53) = 9.86$, $p < .003$, $\eta^2 = .157$). But in an unstable hierarchy, high and low status individuals performed equivalently ($F(1,50) = 0.01$, $p = .924$, $\eta^2 < .001$). Status x Stability interactions were found for dominance ($F(1,104) = 7.42$, $p = .008$, $\eta^2 = .067$) and warmth ($F(1,104) = 4.56$, $p = .035$, $\eta^2 = .042$) in the same direction as the effects on performance. High-status individuals in a stable hierarchy exhibited greater dominance ($F(1,53) = 23.08$, $p < .001$, $\eta^2 = .303$) and warmth ($F(1,53) = 3.97$, $p = .051$, $\eta^2 = .070$) compared to low-status individuals in a stable hierarchy. In an unstable hierarchy, there were non-significant differences between high and low status individuals in dominance and warmth ($ps > .32$, η^2s $<.02$).

Follow-up tests revealed that these interactions were driven by low-status participants, who showed better interview performance and increased dominance in the unstable compared to the stable hierarchy ($ps < .029$, $\eta^2 s > .087$; Fig. 3B). Overall, this pattern of results extends previous work in which low status in unstable hierarchies increases approach-oriented behaviors such as dominance compared to low status in stable hierarchies (19-21) and suggests further that perceiving a hierarchy as unstable may improve low-status individuals' performance in real-world social evaluations.

The interactions between status and hierarchy stability on feeling in control and behavioral responses to stress showed the same patterns with alternative analytical approaches (SI Appendix, Table S8 and S10), and did not statistically differ between male and female participants, with the exception of dominance. For dominance, the joint impact of social status and hierarchy instability, although evident in both sexes, was stronger in men than in women (SI Appendix, Table S5).

Mediation Analyses. Next we conducted mediation analyses to investigate the mechanisms through which status and hierarchy stability influenced interview performance. The *PROCESS* macro (v.2.15; 31) was used to determine if the Status x Stability interaction on interview performance was mediated by feeling in control or indices of endocrine reactivity, controlling for sex (see SI Appendix for statistical analysis details, Table S11 for partial correlations that control for sex). These mediation analyses revealed significant moderated mediations for interview performance via sense of control ($\omega = 0.114$, 95%CI [0.023, 0.275]) and testosterone reactivity ($\omega = 0.087$, 95%CI [0.011, 0.226]) but not cortisol reactivity (ω = -

0.005, 95%CI [-0.092, 0.067]; see SI Appendix Table S12 for conditional indirect effects). We tested another model that included both feeling in control and testosterone reactivity to examine if these two factors were independent mediators. As shown in Fig. 4, the results suggest that social status and hierarchical instability impacted interview performance through two independent pathways: (i) status and hierarchy stability jointly influenced feeling in control, which predicted better interview performance; and (ii) status and stability interacted to influence testosterone reactivity, which predicted decreased interview performance.[2]

Discussion

The present experiment is the first to test the joint influences of social status and hierarchical stability on endocrine, psychological, and behavioral responses to a social-evaluative stressor. Consistent with the hierarchy instability hypothesis, high status buffered stress responses and improved interview performance in a stable hierarchy, but high status boosted stress responses and carried no performance advantage in an unstable hierarchy. This general pattern was observed across hormonal (cortisol and testosterone), psychological (feelings of control), and behavioral (interview performance, dominance, and warmth) responses to the social-evaluative stressor.

Follow-up mediation analyses suggest that status and hierarchy stability jointly impacted overall interview performance through two independent pathways. First, status and hierarchy stability interactively influenced feeling in control, which was positively related to performance evaluations. This result expands psychological theory of stable hierarchies by revealing that hierarchical instability disrupts the impact of status on behavior via feelings of control (22). Second, status and hierarchical stability interactively influenced testosterone reactivity, which negatively predicted interview performance. This biological pathway extends prior research in which higher basal testosterone levels were related to status-seeking motivation and impaired cognitive performance under conditions of experimentally induced status threat (e.g., defeat in competition; 26-28). Elevated testosterone reactivity in the present study may have led individuals to focus on their threatened status rather than the speech task at hand, disrupting cognitive functioning when delivering the speech and undermining performance evaluations. This testosterone pathway is especially noteworthy because most prior studies on social stressors such as the TSST measure cortisol but rarely measure testosterone responses (32). The current study is the first to demonstrate that the joint influence of status and hierarchy stability on performance is mediated by testosterone responses, but follow-up research is needed to confirm this effect and to specify the underlying mechanisms.

These findings provide direct causal support for the hierarchy instability hypothesis and have applications for devising interventions aimed at reducing stress and improving performance. According to the present results, psychological interventions that alter beliefs about the hierarchy or that use role-playing exercises may improve overall performance in social-evaluative situations such as job interviews. For example, a low-status individual who "knows" her place in society — that is, who perceives the status hierarchy as stable — may appear less competent in a job interview, reducing her chances of being hired. But merely holding the *belief* that she can rise in the hierarchy — that is, believing that the hierarchy is unstable — may lead to behaviors that signal competence and improve her chances of being hired. The present results

[2]Mediation analyses for dominance and warmth factors are reported in the SI Appendix.

also suggest that imagining or acting out a high-status role in a stable hierarchy prior to a real-world stressor such as an interview may reduce endocrine stress responses, increase feelings of control, and improve performance. We look forward to follow-up research that builds upon the present findings to test the efficacy of such hierarchy-relevant psychological interventions.

The current results also inform research on status and health. Correlational studies reveal positive associations between societal-level indicators of status, such as socioeconomic status, and better health outcomes (1,2,4). Dysregulation of stress response systems is theorized to be a mechanism through which lower status confers health risk (1,2,4,5,9), potentially through the joint effects of testosterone and cortisol responses on the immune system (33). However, research on status and human health has generally failed to consider the extent to which the stability of the social hierarchy might alter the relationship between status and health (34; but see 35 for some evidence). According to the hierarchy instability hypothesis, the link between lower status and poorer health may hold only in stable status hierarchies. In unstable hierarchies, *higher* status individuals may show dysregulated stress response systems and worse health outcomes. It should be noted, however, that a single, robust endocrine reaction to a stressor is not inherently unhealthy. After all, glucocorticoids such as cortisol mobilize energy as part of a healthy response to stress (7). But when these endocrine responses are persistent and repeated over an extended period of time, they may be detrimental to health and well-being. Thus, it will be important to conduct follow-up longitudinal studies in humans in which features of the hierarchy, endocrine stress responses, and health outcomes are tracked over longer periods of time.

We experimentally manipulated social status in the present study, but our manipulation also contained aspects of social power. Status, which is also referred to as prestige, can be defined as social standing that is granted to individuals for superior skills, success, or knowledge (18). Power is defined as asymmetrical control over resources and tends to be positively correlated with status in real-world hierarchies (36,37). In line with other experimental designs (21,22), our manipulation therefore included features of social status and power in order to emulate real-world hierarchies. The few studies to date that differentiated power and status suggest that they sometimes lead to different outcomes; for instance, status often promotes – whereas power reduces – justice toward others (38). But both power and status are plausible explanations for the interactions between social rank and stability seen in the present study. For example, unstable high-ranking positions lead to behaviors aimed at protecting one's high rank through social motives closely linked to power (39). Yet other evidence suggests that losing a prestigious high-status position is more aversive than losing a powerful position because status is more closely related to an individual's self-concept (40). Additional research will be needed to clarify the extent to which social status and power contribute to the influence of hierarchical rank on acute stress responses and social-evaluative performance in stable and unstable hierarchies.

We provide initial evidence suggesting that status and hierarchy stability influence behavior via acute testosterone reactivity to the stressor. This proposed causal pathway is consistent with rapid, non-genomic effects of steroid hormones on neural functioning and behavior that occur over the course of minutes or seconds (41). But our study design measured naturally occurring hormonal and behavioral stress responses, precluding us from making strong claims about causal direction. It is plausible that the causal direction goes the other way as well, from behavior to hormone changes, which is consistent with theorizing that hormones and behavior influence each other in reciprocal feedback loops (11). Future research can provide

greater insight into causality by pharmacologically inhibiting or increasing testosterone concentrations during social-evaluative stressors.

This study measured salivary hormone concentrations with enzyme immunoassay (EIA), a common technique due to its convenience and cost effectiveness. Methods like liquid chromatography tandem mass spectrometry (LC-MS/MS) are thought to provide more valid measurements compared to EIAs, but the logistical and financial requirements of LC-MS/MS methods have limited their widespread use. Prior research indicates high correspondence between EIAs and LC-MS/MS for salivary cortisol but only moderate correspondence for salivary testosterone (42-44). This moderate correspondence is likely due to known sources of measurement error in EIAs, such as cross-reactivity, particularly in the low range of measurement (e.g., testosterone levels in women; 43). These sources of measurement error likely obscure relationships that exist rather than promote relationships that do not exist (43). Hence, we suspect that the hormonal evidence for the hierarchy instability hypothesis found in the present experiment will be stronger in future LC-MS/MS studies. We look forward to replications that adopt LC-MS/MS methods.

In conclusion, this experiment provides evidence that the influence of status on stress responses and performance depends on the stability of the hierarchy. This knowledge has applications in domains such as business, education, politics, the arts, and medicine. For example, the results can inform hierarchy-based interventions for improving performance in social-evaluative contexts as job interviews, presentations, auditions, and political debates. Because stress is a risk factor for disease and poor well-being (1,2), the findings also have implications for the influence of hierarchy on health.

Materials and Methods

We briefly report methods here and describe full methods and statistical analysis details in the SI Appendix. We tested our predictions by experimentally manipulating social status and hierarchy stability in undergraduate participants (n = 118; 57.3% female; Age: M = 19.8) who were recruited for course credit. Participants were told that, based on their responses to pre-laboratory questionnaires, they had been assigned to complete an upcoming puzzle-building task as either a “manager” (high status) or “builder” (low status) and that another participant (actually a confederate) would perform the unassigned role (20,22). Participants were told specifically that the assignment was based on their “leadership skills and experience” in order to connect the role assignment to prestige (18). In reality, roles were randomly assigned. Participants were also told that the manager would be in charge of directing subordinates in the building process and would evaluate the “builder” at the end of the task to determine how to split bonus money.

Next all participants were asked to complete the TSST, a five-minute speech about one’s qualification for a job and a five-minute serial subtraction math task, in front of a panel of observers. In order to manipulate hierarchy stability, participants were told that their role (manager/builder) could change based on the speech/math task (unstable hierarchy) or that their performance on the task would not affect their role assignment (stable hierarchy). A five-minute preparation period was completed in the presence of a gender-matched confederate in order to increase the salience of the manipulations. Panelists and confederates were blind to participants’ assigned conditions. Participants provided informed consent to participate in a group activity and

perform a speech task. The University of Oregon's Institutional Review Board approved all methods.

Hormones were assayed from saliva collected via passive drool approximately 10 minutes after arriving at the laboratory (baseline), as well as 0, 20, and 40 minutes after the TSST. Participants responded to a prompt asking how "in control" they felt after assignment to status and stability conditions and after the TSST, which was included as a separate item in a broader measure of self-reported affect. Three independent observers rated videos of each participant's speech for status-relevant behaviors and two items that assessed overall interview performance (SI Appendix, S9).

Missing Data and Outliers. Three participants did not complete the social stress task, and four did not correctly identify the manager or builder role to which they were assigned, which left 111 participants for the main analyses. One participant did not produce enough saliva to assay, leaving 110 participants for hormone analyses. The remaining hormone data were examined for outliers. One cortisol value and three testosterone values were Winsorized to 3 SD above the means of each offending sample's time point's mean. Two participants' videos were not recorded due to technical difficulties, leaving 109 participants for behavioral analyses.

Manipulation checks. Participants completed manipulation check items ("How do you perceive the status of your role compared to the other role?" and "Do you think your position might change?") and were asked to describe which role they were assigned. Participants assigned to the manager role perceived their role as higher status compared to participants assigned to the subordinate role ($F(1,105)=35.6$, $p<.001$, $\eta^2= .18$). Participants in the unstable hierarchy were more likely to report that their role could change compared to participants in the stable hierarchy (χ^2 (1) = 8.32, p = .004, *Cramer's V* = .276).

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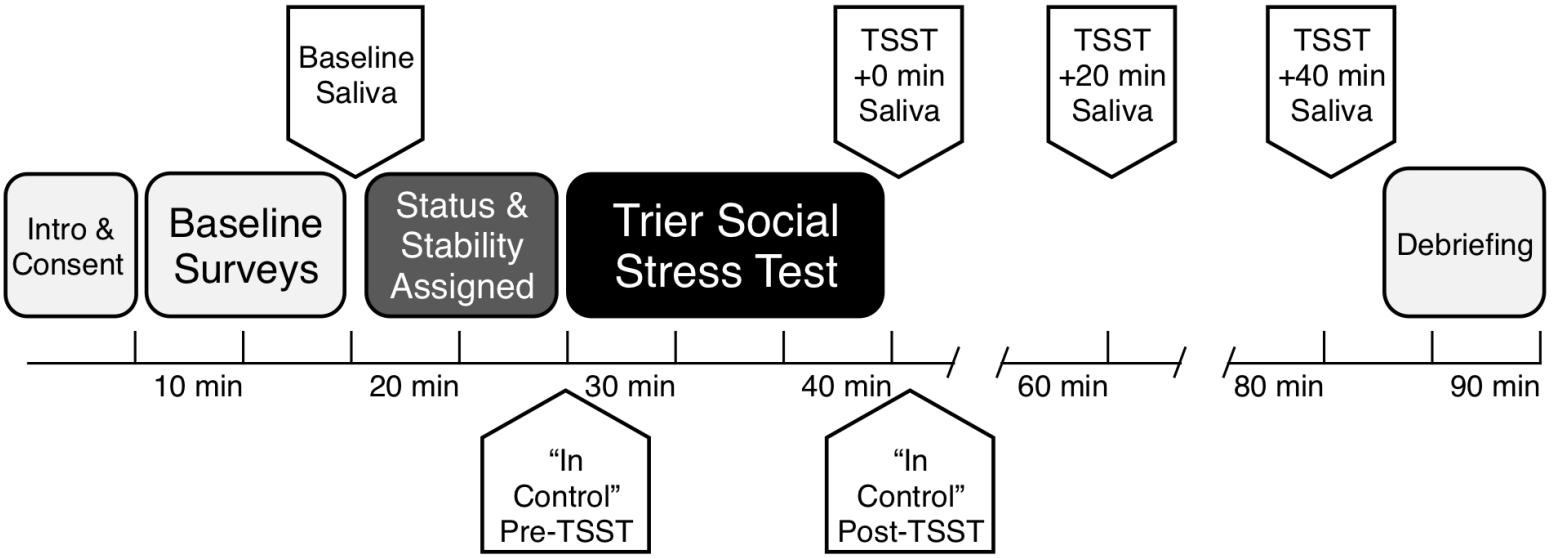
Figure Legends

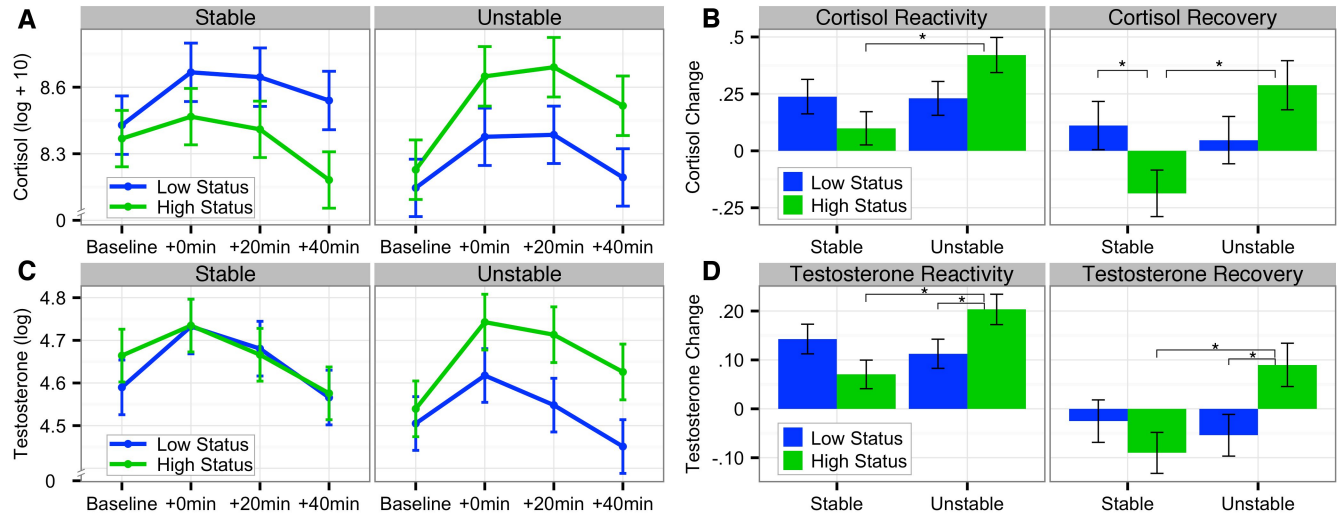
Figure 1. Study timeline depicting experimental manipulations and measurement time of key variables.

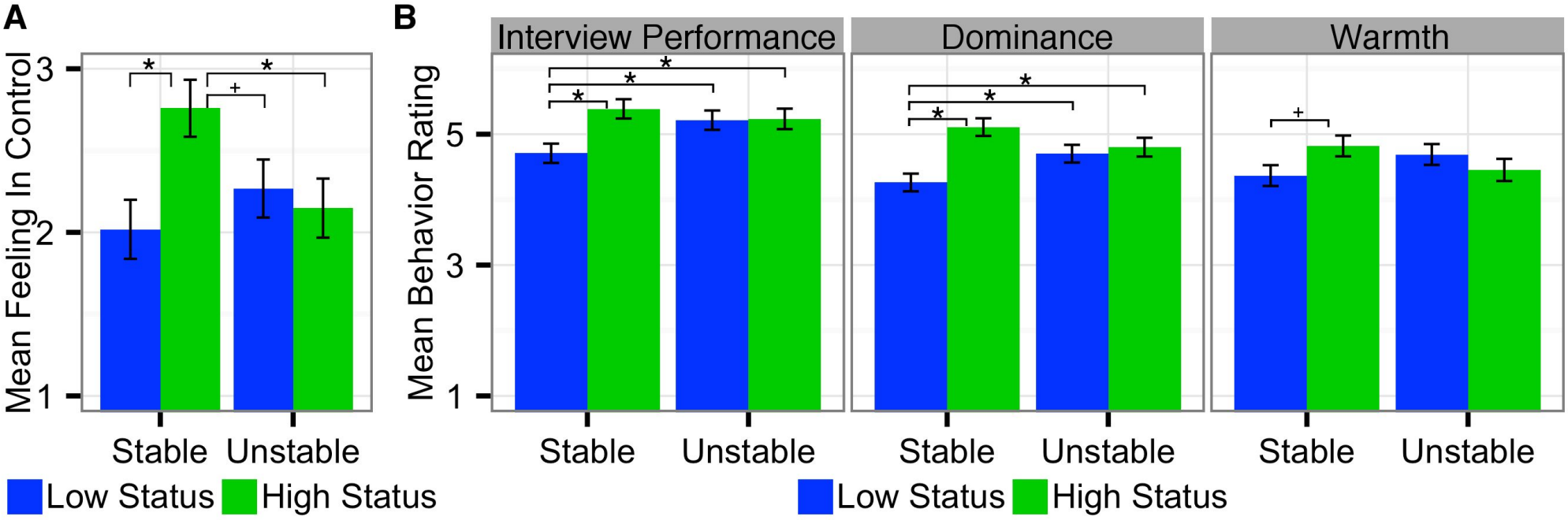
Figure 2. Endocrine stress responses as a function of hierarchy stability and social status **Panel A**. Cortisol concentration (log-transformed plus arbitrary value of 10 added) at four time points: Baseline, +0, +20, and +40 minutes after Trier Social Stress Test (TSST). **Panel B**. Cortisol reactivity and recovery. **Panel C**. Testosterone concentration (log transformed) at four time points, controlling for sex. **Panel D**. Testosterone reactivity and recovery, controlling for sex. All values are estimated marginal means from relevant models; error bars represent standard errors of the means. * = significant uncorrected pairwise comparison at $p < .05$

Figure 3. **Panel A.** Self-reported feelings of control (average of pre- and post-stress measures) as a function of social status and hierarchy stability. **Panel B.** Observed behavior during job interview speech as a function of social status and hierarchy stability. Values are estimated marginal means and error bars represent standard errors of the means. * = significant uncorrected pairwise comparison at $p < .05$; + = $p < .06$

Figure 4. Moderated mediation model showing the indirect, interactive effects of Status x Stability on interview performance via feeling in control and testosterone reactivity. Pathway estimates are reported in unstandardized units (31). Sex is a covariate in the model. The model also includes pathways for the main effects of social status and hierarchical instability on the mediators, but these pathways were excluded from these figures. Conditional indirect effects are shown in SI Appendix, Table S12. **p < .01 *p <. 05


Baseline Saliva
TSST +0 min Saliva
TSST +20 min Saliva
TSST +40 min Saliva
Intro & Consent
Baseline Surveys
Status & Stability Assigned
Trier Social Stress Test
Debriefing
10 min
20 min
30 min
40 min
60 min
80 min
90 min
"In Control" Pre-TSST
"In Control" Post-TSST


A
Stable
Unstable
Cortisol (log + 10)
8.6
8.3
0
Low Status
High Status
Baseline +0min +20min +40min
B
Cortisol Reactivity
Cortisol Recovery
Cortisol Change
.5
.25
0
-.25
*
Low Status
High Status
Stable
Unstable
C
Testosterone (log)
4.8
4.7
4.6
4.5
0
D
Testosterone Reactivity
Testosterone Recovery
Testosterone Change
.20
.10
0
-.10


A
Mean Feeling In Control
3
2
1
*
*
+
Stable
Unstable
Low Status
High Status
B
Mean Behavior Rating
5
3
1
Interview Performance
Dominance
Warmth
*
*
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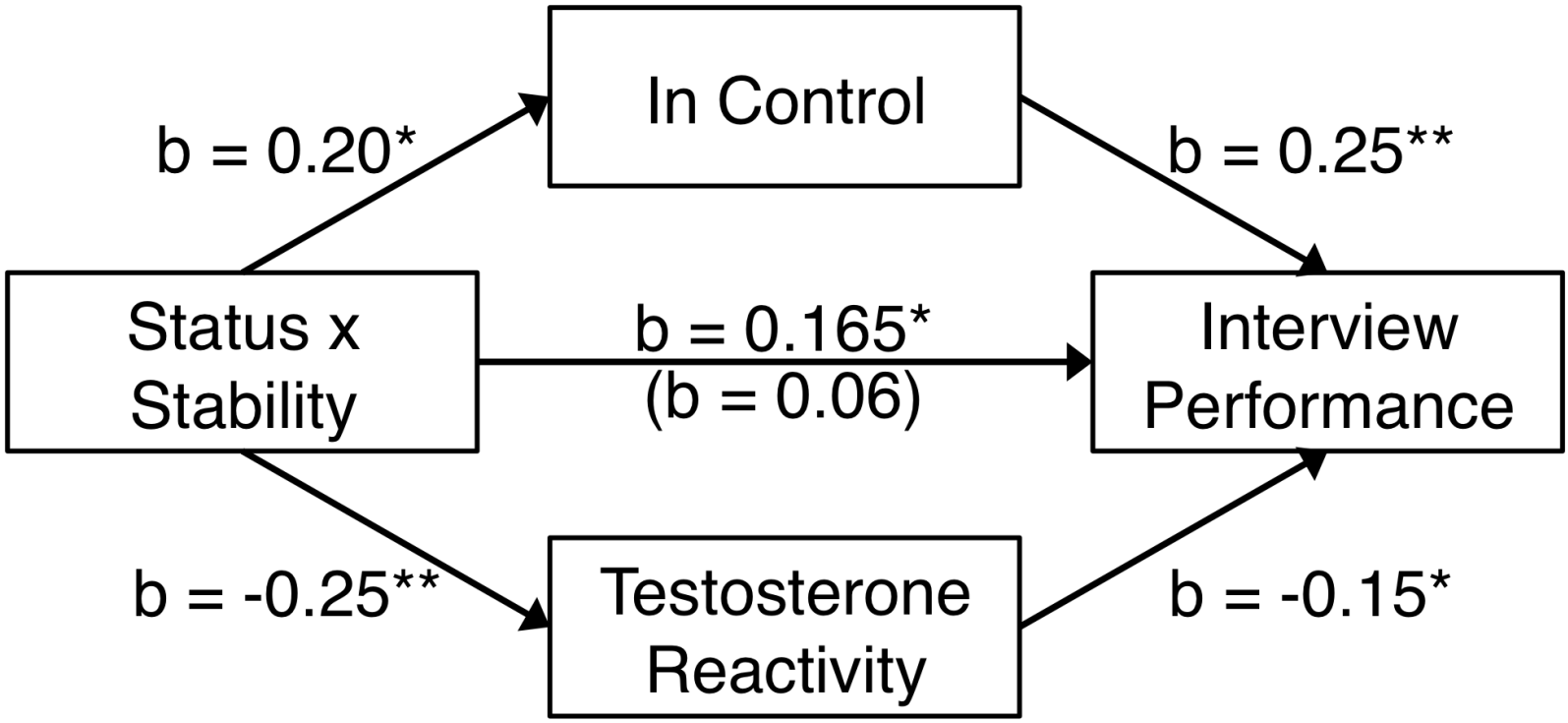
*
*
+
Stable
Unstable
Stable
Unstable
Stable
Unstable
Low Status
High Status



Indices of Moderated Mediation

In Control: ω = 0.100, 95%CI[0.019, 0.242]

Testosterone Reactivity: ω = 0.077, 95%CI[0.007, 0.227]