Article

Group Processes & Intergroup Relations

G P I R

Physiological stress responses to the 2008 U.S. presidential election: The role of policy preferences and social dominance orientation

Group Processes & Intergroup Relations
0(0) 1–13

DOI: 10.1177/1368430211428163
gpir.sagepub.com
SAGE

Sophie Trawalter,[1] Vicki S. Chung,[2] Amy S. DeSantis,[2] Clarissa D. Simon,[2] and Emma K. Adam[2]

Abstract

This study examines physiological stress responses to the 2008 U.S. presidential election. The week before and after Election Day, participants provided three daily saliva samples, assayed for cortisol (a principal "stress hormone") and testosterone. Results revealed that, on Election Day, all participants on average and Republicans in particular exhibited stunted cortisol and testosterone rhythms, perhaps reflecting participants' anticipation. After Election Day, participants' political affiliation was not a strong predictor of physiological responses. Their social dominance orientation—that is, their tolerance of social inequalities—was predictive of responses. Those higher in social dominance orientation had higher cortisol and testosterone morning values. These changes suggest that individuals higher in social dominance orientation were distressed but ready to fight back. The present findings add to an emerging body of work showing that sociopolitical differences can influence biological systems relevant to health and behavior.

Keywords

intergroup anxiety, social dominance orientation, physiological stress, political psychology

Paper submitted 03 November 2010; revised version accepted 03 October 2011.

On November 4th 2008, Barack Obama was elected President of the United States. His election represents a major shift in U.S. politics. It is a shift from a two-term Republican presidency to a Democratic presidency. It is also a shift from a legacy of White presidents to the first Black president. The present work examines responses to this historic election. It considers the physiological responses of a group of American voters who, among other things, vary in how much they support conservative policies and how much they condone social inequalities. It offers evidence that shifts in the sociopolitical hierarchy can affect citizens' physiological functioning.

[1]University of Virginia, USA
[2]Northwestern University, USA

Corresponding author:
Sophie Trawalter, Frank Batten School of Leadership and Public Policy, University of Virginia, PO Box 400893, Charlottesville, VA 22904, USA.
Email: strawalter@virginia.edu

Sociopolitical variables and responses to the election

Democratic elections are essentially competitions for political power and dominance. The outcome of any given political election is a victory for one political party and a defeat for the other party (or parties). In the context of the 2008 U.S. Presidential Election, the election was a victory for Democrats and a defeat for Republicans. It then follows that Republicans may exhibit signs of stress and defeat. Indeed, research has shown that Republicans exhibited physiological responses—namely, increases in cortisol and decreases in testosterone—just minutes following the announcement of the election outcome (Stanton, Beehner, Saini, Kuhn, & LaBar, 2009; Stanton, LaBar, Saini, Kuhn, & Beehner, 2009). These responses suggest that Republicans felt distressed and submitted to defeat.

Political affiliation may not be the most relevant variable when considering people's longer term responses to the 2008 U.S. election, however. Treating political parties as monolithic groups may obscure important nuances in the views and lives of U.S. voters. Indeed, Republican and Democrat voters have complex policy preferences across myriad domains, from abortion to global warming. For instance, in 2008, 36% of Republicans were "prochoice" and 33% of Democrats were "prolife," defying conventional party stereotypes (Gallup, 2009). For those who prefer certain conservative policies, the presidency of Barack Obama may be a threat to their policy interests. For those who prefer liberal policies, his presidency may secure their policy interests. Hence, we might expect individuals' responses to the 2008 election over time to reflect the tenacity with which they hold conservative or liberal policy preferences.

Republicans and Democrats also vary in how much they accept the existing status hierarchy and the social inequality it confers (Jost, Glaser, Kruglanski, & Sulloway, 2003; Pratto, Sidanius, Stallworth, & Malle, 1994). Most societies are socially stratified with some groups of individuals at the top of the hierarchy and others at the bottom (Sidanius & Pratto, 1999). In the USA, the hierarchy is and has been in part race-based, with Whites at the top and racial minority groups—Blacks in particular—at the bottom of the hierarchy. Individuals vary in the extent to which they endorse this hierarchical arrangement (Pratto et al., 1994). Some perceive the hierarchy as legitimate and uphold it. These individuals are high in social dominance orientation (SDO). For those high in SDO, Barack Obama's win challenges the historical dominance of White men. His win is a defeat. In contrast, his win is a victory for those low in SDO, who reject and who may even want to dismantle the existing hierarchy. Accordingly, we might expect individuals' responses to the 2008 election to reflect their levels of social dominance orientation.

Physiological stress responses to the election

Defeat and the consequent loss of status are stressful (Björkqvist, 2001), especially for those who value status and dominance (McClelland, 1989; Wirth, Welsh, & Schultheiss, 2006). Not surprisingly then, responses to defeat can resemble those to stressful situations, including increased arousal and negative mood (Gilbert, Allan, Brough, Melley, & Miles, 2002; Levitan, Hasey, & Sloman, 2000). Responses to defeat and stress also trigger physiological processes designed to assist with coping in the short and longer term (Chrousos & Gold, 1992; Kemeny, 2003; Sapolsky, Romero, & Munck, 2000). In the present study, we examined these physiological stress responses to the 2008 presidential election for several reasons. First, physiological stress responses are not subject to self-presentation concerns (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Page-Gould Mendoza-Denton, Alegre, & Siy, 2010). Individuals reluctant to report their distress about this election would nonetheless exhibit signs of physiological distress. Second, physiological stress-related responses have been linked to specific psychological states. As we will detail in what follows, changes in cortisol have been linked to distress (e.g., Dickerson & Kemeny, 2004) and changes in testosterone have been linked to dominance and motivation to gain dominance (e.g., Mazur &

Booth, 1998). These psychological states (distress and dominance) were those of interest. Third, cortisol rhythms and testosterone are related to psychological well-being and health (e.g., Gunnar & Vazquez, 2001; Sephton, Sapolsky, Kraemer, & Spiegel, 2000), making these outcomes especially important to consider. Finally, if voters exhibited signs of physiological distress and defeat days after the election, we would have better evidence that the election had a profound impact on voters' functioning. For these reasons, we used repeated physiological measures the week before and the week of the 2008 election to gain insight into voters' reactions to this election.

As noted, defeat including social and political defeat triggers physiological processes designed to assists with coping in the short and longer term. Within seconds, the sympathetic-adrenal-medullary (SAM) system is activated. Its activation results in the release of epinephrine also known as adrenaline. This "adrenaline rush" increases heart rate, lung function, and mobilizes resources (e.g., glucose). In other words, SAM system reactivity can facilitate coping; it enables the "fight or flight" response. Under some conditions, the hypothalamic-pituitary-adrenal (HPA) axis is also activated. Social threats including defeat and loss of status are powerful triggers of this axis (Dickerson & Kemeny, 2004; Sapolsky, 1986, 2004). The activation of the HPA axis instigates a cascade of neuroendocrinological events, resulting in the release of cortisol into the bloodstream. This cortisol response sustains and modifies SAM system activity, and modifies the activity of multiple other physiological systems; for example, it facilitates glucose mobilization, to provide extra energy for coping.

The HPA axis can also facilitate coping day to day and across days through modifications of its diurnal rhythm. Under optimal conditions, cortisol levels are high upon waking, increase sharply 30–45 min after waking (the cortisol awakening response or CAR for short), and then decline across the day to a nadir at the end of the waking day (Adam, 2006; Adam & Kumari, 2009; Kirschbaum & Hellhammer, 1989; Pruessner et al., 1997). According to the "boost" hypothesis, this diurnal rhythm may shift to accommodate energy needs (Adam, Hawkley, Kudielka, & Cacioppo, 2006). Specifically, on days following a social stressor, high morning cortisol values and/or large CARs can provide an energy "boost" for dealing with the demands of a new day. On Election Day, we might expect those who lost the election to exhibit cortisol increases immediately following the election outcome (as in Stanton, LaBar, et al., 2009). On days after Election Day, we might expect them to have higher morning values and/or larger CARs, to mobilize resources and cope with the stress of defeat.

Defeat can also affect the hypothalamic-pituitary-gonadal (HPG) axis (Mazur & Booth, 1998; Sapolsky, 1986). HPG axis activation results in the release of LH and FSH, and "sex hormones" including testosterone. The bulk of research on testosterone and defeat finds that status-relevant behavior and dominance are associated with higher testosterone (Archer, 2006; Cashdan, 1995; Dabbs & Hargrove, 1997; Mazur & Booth, 1998; Mazur, Booth, & Dabbs, 1992). Additionally, winning (the realization of dominance) and defeat (the loss of dominance) are often accompanied by increases and decreases in testosterone levels, respectively (Booth, Shelley, Mazur, Tharp, & Kittok, 1989; Elias, 1981; Gladue, Boechler, & McCaul, 1989; Kemper, 1990; Mazur et al., 1992; Mazur & Lamb, 1980; McCaul, Gladue, & Joppa, 1992). There are notable exceptions to these findings, however. Psychological and structural variables can moderate the relationship between defeat and testosterone. Highly dominant individuals and those who choose to fight back in response to defeat often exhibit testosterone increases—not decreases—after defeat (Mehta & Josephs, 2006; Sapolsky, 1986). For example, in one study (Mehta & Josephs, 2006), participants competed against another player. Unbeknownst to participants, the competition was rigged so they could be randomly assigned to win or lose. Results revealed that some "losers" exhibited marked increases in testosterones. Interestingly, "losers" who exhibited such increases were more likely to want a rematch compared to those who exhibited decreases. Momentary testosterone increases thus

seem to reflect individuals' propensity to take on the challenge of defeat and redouble efforts to regain dominance.

Whether defeat can lead to longer lasting changes in testosterone levels is unknown. To our knowledge, the time course and duration of testosterone responses to defeat have not been systematically studied. What is known is that testosterone, like cortisol, has a diurnal rhythm. Levels are high upon waking and decrease across the day (Granger et al., 2003; Plymate, Tenover, & Bremner, 1989; Resko & Eik-Nes, 1966). It thus seems reasonable to assume that defeat could lead to shifts in testosterone rhythms across days, to further bolster efforts to regain dominance, just like stress can lead to shifts in cortisol rhythms across days, to further aid with coping.

The present study examined whether the 2008 U.S. presidential election affected cortisol and testosterone diurnal rhythms of a group of voters days before and after Election Day 2008. We expected party affiliation to predict changes in rhythms but remained open to the possibility that policy preferences and/or SDO might also predict rhythms. To be sure, the election was a competition between a Republican and a Democratic candidate. Barack Obama's win was a defeat for Republicans. This election, however, was also a competition between a conservative and a liberal candidate in an increasingly polarized political, ideological climate. Viewed in this light, Obama's win was a defeat for conservatives. Finally, for the first time in history, this election was also a competition between a White man and a Black man. Obama's win may have been a defeat for those high in SDO—for those who condoned the social hierarchy with White men "on top." In other words, the election may have been a defeat for any number of voters, not only Republicans.

Methods

Participants

We recruited participants via flyers posted on campus and word of mouth. Of all the individuals who expressed interest in the study, 65 individuals were selected for participation. Individuals were selected for participation if they were (a) self-identified White/Caucasian or Black/African American, (b) 18 to 40 years old, (c) U.S. citizens who intended to vote in the 2008 presidential election, and (d) invested in their candidate of choice (i.e., 5 or higher on a 7-point scale assessing how strongly they felt about their choice). Over the course of the study, six participants dropped out and 10 did not complete enough diaries or saliva samples to examine their responses to the election. The final sample of 49 was 24% Black, 67% female, and 33% Republican. Ages ranged from 18 to 31 (M = 22, SE = 3.6). Most participants were college students (70%). The rest were working adults. Participants received $60.00 for their participation.

Materials

Preliminary survey The preliminary survey consisted of demographic questions, a policy preference scale (Hennington, 1996), and the SDO scale (Pratto et al., 1994). The policy preference scale assesses preferences for 12 policies (e.g., death penalty, gay rights, legalization of marijuana). Respondents indicated their support for these policies on 3-point scales. We reverse-coded liberal policies and averaged across items so that higher numbers denote more conservative policy preferences. Scores ranged from 1.0 to 2.83 (M = 1.7, SE = .50). Not surprisingly, relative to Democrats, Republicans scored significantly higher on the (conservative) policy preference scale, $t(47) = 4.71$, $p < .001$. There was no gender effect, $t(47) = .01$, $p = .99$, or race effect, $t(47) = 1.03$, $p = .31$, despite all Black participants being Democrats.

The SDO scale assesses the extent to which individuals endorse antiegalitarian beliefs and systems. This scale consists of 16 statements such as "Superior groups should dominate inferior groups" and "It's probably a good thing that certain groups are at the top and other groups are at the bottom." Participants indicated their agreement with each statement on 7-point scales. Scores ranged from 1 to 6 (M = 2.5, SE = 1.3). As expected, Republicans' SDO scores were significantly higher than those of Democrats, $t(47) = 5.35$, $p < .0001$ (M = 3.61 and 1.78), and White participants' SDO scores were

significantly higher than those of Black participants, $t(47) = 5.85$, $p < .0001$ ($M = 2.68$ and $M = 1.32$). Male and female participants' SDO scores did not differ significantly, $t(47) = .25$, $p = .81$.

Daily diary The daily diary included several covariate measures. Participants were asked to report their caffeine and nicotine use, variables known to affect cortisol rhythms (e.g., Kirschbaum & Hellhammer, 1989; Lovallo et al., 2005). All but one participant were nonsmokers and thus we did not control for nicotine in our analyses. Participants were also asked questions about their sleep—how well they slept and whether they woke up feeling rested.

Saliva sampling Saliva kits consisted of straws, vials, and vial labels. Saliva was collected through passive drool (i.e., spitting through a small straw into a vial). Participants were instructed not to eat, drink, or brush their teeth during the 30 min before each sample. Due to low levels of compliance on Mondays and Fridays, we assayed samples taken on Tuesday–Thursday of each week.

Procedures

Between October 15th and 27th, 2008, participants came to the lab to complete surveys and get their saliva kits. Then, Monday through Friday, the week before and the week of the election, participants completed a diary entry each evening and provided saliva samples three times per day—upon waking, 30 min after waking, and at bedtime. At the end of the study, samples were aliquoted and half of the samples were shipped on dry ice to the University of Trier, where they were assayed for cortisol. The other half of the samples was assayed for testosterone at Northwestern University. The coefficients of variation (CV) for these assays were less than 10% and thus satisfactory.

Results

Cortisol responses

Cortisol values were positively skewed and therefore log-transformed. Due to the nested nature of the data (samples nested in days nested in participants), we constructed three-level models in HLM (Bryk, Raudenbush, & Congdon, 1996).[1] As in previous work (e.g., Adam et al., 2006; Doane & Adam, 2010), at Level 1, we modeled the cortisol slope across the day and the CAR—the cortisol increase occurring in the first 30 min after waking. Specifically, we modeled cortisol levels as a function of time since waking (i.e., the slope/ rate of change of cortisol levels across the waking day). We also included a dichotomous variable, indicating whether cortisol levels were from the second morning sample (i.e., 30 min after waking) to model the CAR. At Level 2, we added election period (i.e., Election Day and postelection; 1 = yes, 0 = no) to examine whether morning values, CARs, and/or slopes differed during the preelection, Election Day, or postelection periods. At Level 3, we added individual differences in sociopolitical variables (political affiliation, policy preferences, or SDO) to examine whether cortisol changes during the election periods varied as a function of individual differences. In addition, we added a number of covariates known to influence cortisol levels. At Level 2, we added caffeine intake and wake-up time and, at Level 3, we added gender (male; 1 = yes, 0 = no) and race (White; 1 = yes, 0 = no). We constructed three such HLM models—for political affiliation, policy preferences, and SDO.

Recall that, under normal conditions, cortisol levels are high in the morning, increase 30–45 min after waking (the CAR), and then decline across the waking day. All three models revealed this expected diurnal rhythm. Before Election Day, participants had high morning levels, $G = -.65$, $p < .0001$, followed by a sharp increase 30 min after waking (the CAR), $G = .17$, $p < .0001$, and then a steady decline across the day $G = .05$, $p < .0001$, irrespective of political party affiliation, policy preferences, or SDO. These models also revealed the expected effects of caffeine, wake time, gender, and race. The interested reader can view these parameter estimates and test of statistics in Table 1. Here, we focus on the effects of election period and sociopolitical differences on cortisol rhythms.

All three models revealed a significant shift in participants' rhythms on Election Day. All participants,

Table 1. Summary of cortisol models, main predictors and covariates

	Preelectionbaseline			Election Daychanges			Postelectionchanges		
G (SE) P	AM	CARs	Slopes	AM	CARs	Slopes	AM	CARs	Slopes
Intercepts	−.64 (.03) < .0001	.16 (.03) < .0001	−.05 (.003) <.0001	−.12 (.05) .01	ns	.01 (.004) .004	ns	ns	ns
Political affiliation (Model 1)	ns	ns	ns	−.21 (.09) .03	ns	ns	ns	ns	ns
Policy preferences (Model 2)	ns	ns	ns	−.07 (.03) .06	ns	ns	ns	ns	ns
SDO (Model 3)	ns	ns	ns	ns	ns	ns	.07 (.03) .02	ns	−.008 (.003) .02
Interpretation	All participants on average had strong diurnal rhythms, regardless of political variables			On Election Day, all participants on average had flatter slopes; Republicans had lower morning values			After Election Day, higher SDO participants had higher morning values and steeper slopes		
White	.14 (.04) .04	ns	ns	ns	ns	ns	ns		ns
Male	-.14 (.06) .03	ns	ns	ns	ns	ns	.21 (.07) .008	−.17 (.10) .08	ns
Caffeine	ns	ns	.004 (.002) .01						
Wake time	ns	−.06 (.03) .03	−.004 (.002) .03						

Note: Estimates for morning levels, CARs, and slopes before, on, and after Election Day were virtually identical across models. Likewise, estimates for covariates, race, and gender were identical across models. We report estimates from a baseline model (with covariates, without sociopolitical variables). Averaging across the three models yields the same estimates.

on average, exhibited flatter slopes on Election Day, $G = .009$, $p = .01$. In two of the three models (i.e., the model for political preference and the model for SDO), all participants, on average, also exhibited significant decreases in morning values, $G = -.12$, $p = .01$ and $G = -.11$, $p = .02$, contributing to these flatter slopes. In the model for political affiliation, these decreases in morning values were only significant for Republican participants, $G = -.21$, $p = .03$. What is clear from these three models is that Election Day affected participants. All participants, on average, had flatter slopes that day relative to previous days, and these flatter slopes seemed to be the result of lower morning values, especially for Republicans. These flatter slopes may reflect a "blunting" of hypothalamic-pituitary-adrenal (HPA) axis activity while participants awaited the election's outcome. We return to this possibility in the discussion.

After Election Day, only the model for SDO revealed significant effects on cortisol rhythms.

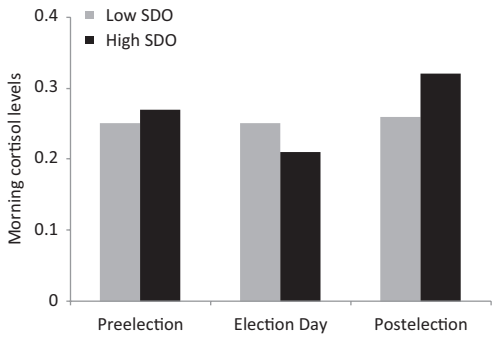

Figure 1. Morning cortisol levels as a function of SDO and election period.

As can be seen in Figure 1, relative to low-SDO participants, high-SDO participants exhibited higher morning values after Election Day relative to days before the election, $G = .07$, $p = .02$. In other words, consistent with the "boost" hypothesis, higher SDO participants seemed to be experiencing a physiological boost on days after the election, presumably to meet the demands of challenging days.

Testosterone responses

Testosterone values were positively skewed and therefore log-transformed. To model testosterone's diurnal rhythm, we modeled testosterone levels as a function of time since waking at Level 1 (as in Granger et al., 2003). As with the cortisol analyses, we then added election period (i.e., Election Day and postelection; 1 = yes, 0 = no) at Level 2. We added individual differences in political variables at Level 3. In addition, we added two Level 3 covariates. We added gender, given that men have significantly higher levels of testosterone than women, and we added race given some claims that testosterone differs between racial groups (e.g., Ellis & Nyborg, 1992; cf. Rohrmann et al., 2007). Again, we constructed three such HLM models—for political affiliation, policy preferences, and SDO. All models revealed the expected gender difference and no race differences (see Table 2 for parameter estimates and test statistics). Here, again, we focus on the effect of sociopolitical variables on testosterone rhythms.

Recall that, under normal conditions, testosterone levels are high in the morning and then decline across the waking day. All three models revealed this expected diurnal rhythm. Before Election Day, participants' morning values were high, $G = 1.88$, $p < .0001$, and declined across the day, $G = -.02$, $p < .0001$, irrespective of political party affiliation, policy preferences, or SDO. On Election Day, all participants, on average, exhibited flatter slopes, $G = .004$, $p < .001$, mirroring the cortisol results. These flatter slopes persisted somewhat, postelection, $G = .003$, $p = .08$, although this effect was only marginal. As with the cortisol data, SDO predicted testosterone levels after Election Day, $G = .03$, $p = .03$. As can be seen in Figure 2, relative to lower SDO participants, higher SDO participants exhibited higher morning testosterone levels after the election. There was also a marginal effect of policy preference such that those who favor conservative policies exhibited flatter slopes postelection compared to their preelection slopes $G = .003$, $p = .06$.

A "retrospective" look at physiological responses and sociopolitical variables

The analyses thus far reveal that, relative to lower SDO participants, higher SDO participants exhibited higher morning cortisol and testosterone levels postelection. To test the predictive utility and strength of these findings, we examined whether participants' cortisol and testosterone responses postelection (namely, whether they showed increases in cortisol and testosterone, testosterone only, cortisol only, or neither cortisol nor testosterone) were predictive of their party affiliation, preference for conservative policies, and/or SDO levels. That is, we examined whether physiological responses retrospectively predicted sociopolitical individual differences. As can be seen in Figure 3, physiological profiles mapped on to SDO scores. Participants who exhibited both cortisol and testosterone increases were highest on SDO, followed by those who exhibited only testosterone increases, and those who exhibited only cortisol increases; those who exhibited neither cortisol nor testosterone increases were lowest on SDO. A linear

Table 2. Summary of testosterone models, main predictors and covariates

	Preelectionbaseline		Election Daychanges		Postelectionchanges	
G (SE) P	AM	Slopes	AM	Slopes	AM	Slopes
Intercepts	1.88 (.02) < .0001	−.02 (.001) < .0001	ns	.004 (.002) .04	ns	.003 (.002) .11
Political Affiliation (Model 1)	ns	ns	ns	ns	ns	ns
Policy Preferences (Model 2)	ns	ns	ns	ns	ns	.003 (.002) .06
SDO (Model 3)	ns	ns	ns	ns	.03 (.02) .03	ns
Interpretation	All participants on average had strong diurnal rhythms		On Election Day, all participants on average had flatter slopes		Postelection, higher SDO participants had higher morning values	
White	ns	ns	ns	ns	ns	ns
Male	.45 (.05) < .0001	ns	ns	ns	−.08 (.03) .03	ns

Note: We report estimates from a baseline model (with covariates, without sociopolitical variables). Averaging across the three models yields the same estimates.

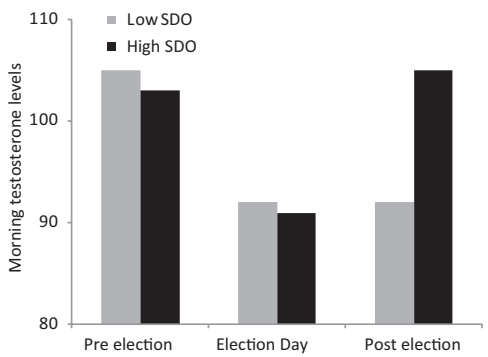

Figure 2. Morning testosterone levels as a function of SDO and election period.

contrast (−3 −1 1 3) revealed a relationship between physiological profile and SDO, $F(1, 48) = 3.42$, $p = .07$. This linear pattern was not observed for policy preferences, $F(1, 48) = .44$, $p = .51$, or political affiliation, $F(1, 48) = 1.41$, $p = .24$.

Discussion

This study revealed that participants were affected by the 2008 U.S. election. They exhibited flatter cortisol and testosterone slopes on Election Day. This shift in rhythms may reflect the body's response to anticipation—the "biology of suspense." Before the election outcome was known, participants could not know whether or how to cope. The activity of their HPA and hypothalamic-pituitary-gonadal (HPG) axes was blunted, perhaps to conserve energy and ready the body for mobilization. This interpretation is consistent with a recent meta-analysis, which found that HPA axis activity is diminished when persistent stress is or becomes uncontrollable; often, morning

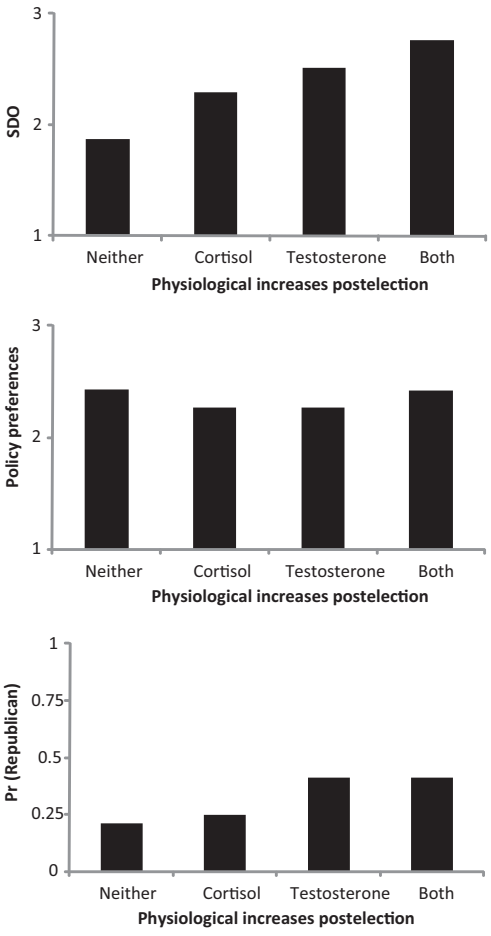

Figure 3. Levels of SDO (top panel), policy preferences (middle panel), and political affiliation (bottom panel) as a function of physiological responses to the election.

cortisol values are lower than expected and, as a result, cortisol slopes are flatter (Miller, Chen, & Zhou, 2007). The authors of this meta-analysis posited that this blunting may be a sign of physiological toughening—"steeling oneself" for what is to come. In the context of the present study, participants seemed to be steeling themselves for the election outcome.

On days after the election, SDO was associated with shifts in diurnal rhythms. Compared with lower SDO participants, higher SDO participants exhibited higher cortisol morning values postelection. These increases may have provided participants with an extra "boost" of energy to help them manage the demands of the day—a new day in which their sociopolitical ideology was contested. This interpretation is consistent with the "boost" hypothesis (Adam et al., 2006) as well as recent work showing that individuals under persistent stress have higher morning cortisol values if they perceive the stressor to be controllable (Miller et al., 2007). Perhaps higher SDO participants perceived the election outcome as a stressor (as in Stanton, Beehner, et al., 2009) but one they could manage and overcome.

The testosterone findings are consistent with this interpretation. After Election Day, relative to individuals low in SDO, those higher in SDO exhibited higher testosterone morning values. Previous work has shown that dominant individuals do not automatically or necessarily submit to defeat. They may redouble efforts to threaten and regain dominance—a response associated with testosterone increases (Mehta & Josephs, 2006; Sapolsky, 1986). In the context of the present work, it seems that lower SDO participants withdrew efforts once they won the election while higher SDO participants redoubled their efforts to fight back. This possibility is especially intriguing when considering Stanton, LaBar, et al.'s (2009) findings that Republicans exhibited decreases in testosterone moments after the election outcome was announced. It may be that Republicans submitted to defeat in the moment but that those high in SDO (a loose subset of Republicans) were ready to fight back soon thereafter, days after the election.

The cortisol and testosterone data taken together thus suggest that higher SDO participants may have felt distressed about the election outcome but were ready to fight back. The current political landscape provides some anecdotal evidence for this interpretation of our data. Shortly after President Obama took office, the Tea Party movement emerged. According to a 2010 *New York Times*/CBS poll, 92% of Tea Party members fear that President Obama's policies are moving the USA toward socialism; and, researchers

and journalists have described members of this movement as "racially resentful," a description fitting of high-SDO individuals (Baretto & Parker, 2010; Campo-Flores, 2010). Indeed, research has shown that high-SDO individuals are likely to believe that "the root cause of most of the social and economic ills of Blacks is the weakness and instability of the Black family" and that "on the whole, Black people don't stress education and training [enough]" (items from Katz & Hass, 1988 used in Pratto et al., 1994). More to the point, "tea partiers" have organized local and national protests. They are taking on the challenge of their electoral defeat and fighting back.

While considering the potential applications and implications of the present study, it is important to note some of its limitations. First, our sample size was small. We could not examine the election's impact on individuals of intersecting social identities (e.g., Black men vs. Black women vs. White women vs. White men; male Republicans vs. male Democrats vs. female Republicans vs. female Democrats). That being said, these social identities are manifested in SDO, at least in part. Our data do then speak to how social identities shape responses to shifts in hierarchies to the extent that these identity combinations confer different levels of SDO. Future work will need to utilize larger, more diverse samples to shed light on the relationship between social identities and responses to sociopolitical shifts.

In addition, our timeline was relatively short. It is not clear whether cortisol and testosterone rhythms on days before Election Day were representative of participants' "normal" diurnal rhythms. Indeed, we think participants' high testosterone levels on days before Election Day may have reflected their eagerness to gain dominance in this election. Participants, irrespective of political affiliation, policy preferences, or SDO, seemed ready for a fight. Nevertheless, the fact that SDO predicted changes in diurnal rhythms from pre- to postelection and predicted these changes better than other sociopolitical variables is striking. A priori, we expected political affiliation or policy preferences to be much stronger predictors of longer term physiological responses to the election. Whether the responses we observed persisted over the following weeks and months remains unknown. Given that Barack Obama's presidency is changing the sociopolitical context—not only on Election Day but over time through media exposure, policy changes, etc.—it may continue to shape people's day-to-day experiences and opinions (e.g., Lundberg, 2011). It would be interesting to see whether SDO continues to predict physiological functioning today.

Finally, it remains unknown whether results would have been different had Barack Obama's opponent, John McCain, won the election. What we do know is that the election of Barack Obama seemed to elicit marked shifts in physiological rhythms among some individuals. These limitations notwithstanding, the present study replicates and extends previous work in important ways:

First, it adds to a growing literature on the psychological meaning of political events. Of the three political variables under consideration, SDO predicted postelection physiological responses better than did party affiliation and policy preferences. Accordingly, this work suggests that political affiliation and policy preferences may not always be sufficient to understand how political events affect the lives of voters. Dimensions related to but not synonymous with political affiliation—namely, SDO—also shape how political events are experienced. These findings echo Jost, Glaser, Kruglanski, and Sulloway's (2003) and Pratto et al.'s (1994) contention that one underlying dimension of political beliefs is tolerance and even preference for social inequalities. Here, we find that it is tolerance of inequalities and not policy preferences that predicted voters' physiological responses to the 2008 U.S. election.

Second, the present work underscores the importance of considering the time course of physiological responses (see also Doane & Adam, 2010; Miller et al., 2007). Physiological systems respond to stressful events in characteristic ways in the moment and in different ways over time. In response to challenging events, the HPA and HPG axes can respond quickly (over the course of minutes and hours), increasing cortisol and

decreasing testosterone levels in the body (as in Stanton, Beehner, et al., 2009; Stanton, LaBar, et al., 2009). Over time, these systems can shift their diurnal rhythms to redirect physiological resources, to mobilize resources and provide an extra "boost" of energy to meet the demands of a new day.

Lastly, the present work contributes to an emerging literature on the effects of psychosocial and, in this case, sociopolitical events on physiological systems implicated in health and disease. Extant research suggests that "stress gets under the skin" to affect health and a bulk of that research implicates the HPA axis as one key mechanism (see Adam & Gunnar, 2001; Adler & Ostrove, 1999; Chrousos, 1995; Cohen, Janicki-Deverts, & Miller, 2007; Doane & Adam, 2010; Gunnar & Vazquez, 2001; McEwen, 1998; Miller et al., 2007; Raber, 1998; Rosmond & Bjorntorp, 2000; Sephton et al., 2000). The present work thus suggests that sociopolitical ideology can affect systems related to health and well-being in times of sociopolitical shifts.

Acknowledgments

We gratefully acknowledge the support of a National Institute for Child Health and Human Development grant (Grant 1F32HD055772) to the first author, a William T. Grant Foundation Scholars Award and an Institute for Policy Research Faculty Fellowship to the fifth author, and a Cells to Society Center Seed Grant from the Institute for Policy Research, Northwestern University to the second author. Finally, we wish to thank the Laboratory for Human Biology Research at Northwestern University for conducting the testosterone assays.

Note

Computing average pre- and post-election slopes and using regression (instead of HLM) yielded similar findings. We use HLM in order to control for day-level and person-level variables. Note that the HLM analyses were performed on 740+ samples. These samples were nested in 6 days nested in 49 participants.

References

Adam, E. K. (2006). Transactions among trait and state emotion and adolescent diurnal and momentary cortisol activity in naturalistic settings. *Psychoneuroendocrinology*, *31*, 664–679.

Adam, E. K., & Gunnar, M. R. (2001). Relationship functioning and home and work demands predict individual differences in the diurnal cycle of cortisol in women. *Psychoneuroendocrinology*, *26*, 189–208.

Adam, E. K., Hawkley, L. C., Kudielka, B. M., & Cacioppo, J. T. (2006). Day-to-day dynamics of experience–cortisol associations in a population-based sample of older adults. *Proceedings of the National Academy of Sciences of the United States of America*, *103*, 17058–17063.

Adam, E. K., & Kumari, M. (2009). Assessing salivary cortisol in large-scale, epidemiological research. *Psychoneuroendocrinology*, *34*(10), 1423–1436.

Adler, N. E., & Ostrove, J. M. (1999). Socioeconomic status and health: What we know and what we don't. In N. E. Adler, M. Marmot, & B. S. McEwen (Eds.), *Annals of the New York Academy of Sciences: Vol. 896. Socioeconomic status and health in industrial nations: Social, psychological, and biological pathways* (pp. 3–15). New York: New York Academy of Sciences.

Archer, J. (2006). Testosterone and human aggression: An evaluation of the challenge hypothesis. *Neuroscience and Biobehavioral Reviews*, *30*, 319–345.

Baretto, M., & Parker, C. (2010, May). *Tea party attitudes in Washington state*. Retrieved July 7, 2010, from the University of Washington Institute for the Study of Ethnicity, Race, and Sexuality web site: http://depts.washington.edu/uwiser/racepolitics.html

Björkqvist, K. (2001). Defeat as a stressor in humans. *Physiological Behavior*, *73*, 435–442.

Blascovich, J., Mendes, W. B., Hunter, S. B., Lickel, B., & Kowai-Bell, N. (2001). Perceiver threat in social interactions with stigmatized others. *Journal of Personality and Social Psychology*, *80*, 253–267.

Booth, A., Shelley, G., Mazur, A., Tharp, G., & Kittok, R. (1989). Testosterone, and winning and losing in human competition. *Hormones and Behavior*, *23*, 556–571.

Bryk, A., Raudenbush, S., & Congdon, R. (1996). *Hierarchical linear and nonlinear modeling with the HLM/2L and HLM/3L programs*. Chicago, IL: Scientific Software Int.

Campo-Flores, A. (2010, April 26). Are tea partiers racist? *Newsweek*. Retrieved July 7, 2010, from http://www.newsweek.com/2010/04/25/are-tea-partiers-racist.html

Cashdan, E. (1995). Hormones, sex, and status in women. *Hormones and Behavior*, *29*, 354–366.

Chrousos, G. P. (1995). The hypothalamic-pituitary-adrenal axis and immune-mediated inflammation. *The New England Journal of Medicine*, *332*, 1251–1363.

Chrousos, G. P., & Gold, P. W. (1992). The concepts of stress and stress system disorders: Overview

of physical and behavioral homeostasis. *Journal of American Medical Association*, *267*, 1244–1252.

Cohen, S., Janicki-Deverts, D., & Miller, G. E. (2007). Psychological stress and disease. *Journal of the American Medical Association*, *298*, 1685–1687.

Dabbs, J. M., Jr., & Hargrove, M. F. (1997). Age, testosterone, and behavior among female prisoners. *Psychosomatic Medicine*, *59*, 477–480.

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, *130*, 355–391.

Doane, L. D., & Adam, E. K. (2010). Loneliness and cortisol: Momentary, day-to-day, and trait associations. *Psychoneuroendocrinology*, *35*, 430–441.

Elias, M. (1981). Serum cortisol, testosterone, and testosterone-binding globulin responses to competitive fighting in human males. *Aggressive Behavior*, *7*, 215–224.

Ellis, L., & Nyborg, J. (1992). Racial/ethnic variations in male testosterone levels. *Steroids*, *57*, 72–75.

Saad, L. (2009, May 15). More Americans "pro-life" than "pro-choice" for first time. *Gallup*. Retrieved July 7, 2010, from http://www.gallup.com/poll/118399/more-americans-pro-life-than-pro-choice-first-time.aspx

Gilbert, P., Allan, S., Brough, S., Melley, S., & Miles, J. N. V. (2002). Relationship of anhedonia and anxiety to social rank, defeat and entrapment. *Journal of Affective Disorders*, *71*, 141–151.

Gladue, B., Boechler, M., & McCaul, K. (1989). Hormonal response to competition in human males. *Aggressive Behavior*, *15*, 409–422.

Granger, D. A., Shirtcliff, E. A., Zahn-Waxler, C., Usher, B., Klimes-Dougan, B., & Hastings, P. (2003). Salivary testosterone diurnal variation and psychopathology in adolescent males and females: Individual differences and developmental effects. *Development and Psychopathology*, 15, 431–449.

Gunnar, M. R., & Vazquez, D. M. (2001). Low cortisol and a flattening of expected daytime rhythm: Potential indices of risk in human development. *Development and Psychopathology*, *13*, 515–538.

Hennington, J. P. (1996). A 12-item scale of social conservatism. *Personality and Individual Differences*, *20*, 517–519.

Jost, J. T., Glaser, J., Kruglanski, A. W., & Sulloway, F. (2003). Political conservatism as motivated social cognition. *Psychological Bulletin*, *129*, 339–375.

Kemeny, M. E. (2003). The psychobiology of stress. *Current Directions in Psychological Science*, *12*, 124–129.

Kemper, T. D. (1990). *Social structure and testosterone*. New Brunswick, NJ: Rutgers University Press.

Kirschbaum, C., & Hellhammer, D. H. (1989). Salivary cortisol in psychobiological research: An overview. *Neuropsychobiology*, *22*, 150–169.

Levitan, R. D., Hasey, G., & Sloman, L. (2000). Major depression and the involuntary defeat strategy: Biological correlates. In L. Sloman & P. Gilbert (Eds.), *Subordination and defeat: An evolutionary approach to mood disorders and their therapy* (pp. 95–118). Mahwah, NJ: Lawrence Erlbaum Associates.

Lovallo, W. R., Whitsett, T. L., Al'absi, M., Sung, B. H., Vincent, A. S., & Wilson, M. F. (2005). Caffeine stimulation of cortisol secretion across the waking hours in relation to caffeine intake levels. *Psychosomatic Medicine*, *67*, 734–739.

Lundberg, K. B. Post-racial America? Racialization and polarization of policy-related judgments following the 2008 U.S. Presidential Election. Unpublished Masters Thesis, University of North Carolina, Chapel Hill.

Mazur, A., & Booth, A. (1998). Testosterone and dominance in men. *Behavioral and Brain Sciences*, *21*, 353–397.

Mazur, A., Booth, A., & Dabbs, J., Jr. (1992). Testosterone and chess competition. *Social Psychology Quarterly*, *55*, 70–77.

Mazur, A., & Lamb, T. (1980). Testosterone, status, and mood in human males. *Hormones and Behavior*, *14*, 236–246.

McCaul, K., Gladue, B., & Joppa, M. (1992). Winning, losing, mood, and testosterone. *Hormones and Behavior*, *26*, 486–506.

McClelland, D.C. (1989). Motivational factors in health and disease. *The American Psychologist*, *44*, 675–683.

McEwen, B. S. (1998). Protective and damaging effects of stress mediators. *The New England Journal of Medicine*, *338*, 171–179.

Mehta, P. H., & Josephs, R. A. (2006). Testosterone change after losing predicts the decision to compete again. *Hormones and Behavior*, *50*, 684–692.

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological Bulletin*, *133*, 25–45.

New York Times/CBS. (2010, April 12). National survey of tea party supporters. *New York Times*. Retrieved July 7, 2010, from http://documents.nytimes.com/new-york-timescbs-news-poll-national-survey-of-tea-party-supporters?ref=politics

Page-Gould, E., Mendoza-Denton, R., Alegre, J. M., & Siy, J. O. (2010). Understanding the impact of cross-race friendships on interactions with novel

outgroup members. *Journal of Personality and Social Psychology*, *98*, 775–793.

Plymate, S. R., Tenover, J. S., & Bremner, W. J. (1989). Circadian variation in testosterone, sex hormone-binding globulin and calculated non-sex hormone-bonding globulin bound testosterone. *Journal of Andrology*, *10*, 366–371.

Pratto, F., Sidanius, J., Stallworth, L. M., & Malle, B. F. (1994). Social dominance orientation: A personality variable predicting social and political attitudes. *Journal of Personality and Social Psychology*, *67*, 741–763.

Pruessner, J. C., Gaab, J., Hellhammer, D. H., Lintz, D., Schommer, N., & Kirschbaum, C. (1997). Increasing correlations between personality traits and cortisol stress responses obtained by data aggregation. *Psychoneuroendocrinology*, *22*, 615–625.

Raber, J. (1998). Detrimental effects of chronic hypothalamic-pituitary-adrenal axis activation. *Molecular Neurobiology*, *18*, 1–22.

Resko J. A., & Eik-Nes K. B. (1966). Diurnal testosterone levels in peripheral plasma of human male subjects. *Journal of Clinical Endocrinology*, *26*, 573–576.

Rohrmann, S., Nelson, W. G., Rifai, N., Brown, T. R., Dobs, A., Kanarek, N., … Platz, E. A. (2007). Serum estrogen, but not testosterone, levels differ between Black and White men in a nationally representative sample of Americans. *Journal of Clinical Endocrinology and Metabolism*, *92*, 2519–2525.

Rosmond, R., & Bjorntorp, P. (2000). The hypothalamic-pituitary-adrenal axis activity as a predictor of cardiovascular disease, type 2 diabetes, and stroke. *Journal of Internal Medicine*, *247*, 188–197.

Sapolsky, R. M. (1986). Stress-induced elevation of testosterone concentrations in high ranking baboons: Role of catecholamines. *Endocrinology*, *118*, 1630–1635.

Sapolsky, R. M. (2004). Social status and health in humans and other animals. *Annual Review of Anthropology*, *33*, 393–418.

Sapolsky, R. M., Romero, L. M., & Munck, A. U. (2000). How do glucocorticoids influence stress responses? Integrating permissive, suppressive, stimulatory, and preparative actions. *Endocrine Reviews*, *21*, 55–89.

Sephton, S. E., Sapolsky, R. M., Kraemer, H. C., & Spiegel, D. (2000). Diurnal cortisol rhythm as a predictor of breast cancer survival. *Journal of the National Cancer Institute*, *92*, 994–1000.

Sidanius, J., & Pratto, F. (1999). *Social dominance: An intergroup theory of social hierarchy and oppression.* Cambridge, MA: Cambridge University Press.

Stanton, S. J., Beehner, J. C., Saini, E. K., Kuhn, C. M., & LaBar, K. S. (2009). Dominance, politics, and physiology: Voters' testosterone changes on the night of the 2008 United States presidential election. *PLoS ONE*, *4*, e7543. doi: 10.1371/journal.pone.0007543

Stanton, S. J., LaBar, K. S., Saini, E. K., Kuhn, C. M., & Beehner, J. C. (2009). Stressful politics: Voters' cortisol responses to the outcome of the 2008 United States presidential election. *Psychoneuroendocrinology*, *35*, 768–774.

Wirth, M. M., Welsh, K. M., & Schultheiss, O. C. (2006). Salivary cortisol changes in humans after winning or losing a dominance contest depend on implicit power motivation. *Hormones and Behavior*, *49*, 346–352.