When the Heat Is On: The Effect of Temperature on Voter Behavior in Presidential Elections

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Hot temperatures lead to heightened arousal. According to excitation transfer theory, arousal can increase both antisocial and prosocial behavior, depending on the context. Although many studies have shown that hot temperatures can increase antisocial behavior, very few studies have investigated the relationship between temperature and prosocial behavior. One important prosocial behavior is voting. We analyzed state-level data from the United States presidential elections (N = 761). Consistent with excitation transfer theory, which proposes that heat-induced arousal can transfer to other activities and strengthen those activities, changes in temperature and voter turnout were positively related. Moreover, a positive change in temperature was related to a positive change in votes for the incumbent party. These findings add to the literature on the importance of non-ideological and non-rational factors that influence voting behavior.

Keywords: excitation transfer theory, presidential elections, prosocial behavior, temperature, voter turnout, voting result

INTRODUCTION

Hot temperatures can have divergent effects on human behavior (Oishi, 2014). On the one hand, ample studies have shown that hot temperatures have been associated with antisocial behaviors (e.g., assaults, murders; Anderson and Bushman, 2002; Bushman et al., 2005) as well as negative political behaviors, such as political rebellions, and riots (Lombroso, 1911; Schwartz, 1968; Carlsmith and Anderson, 1979). On the other hand, hot temperatures have been associated with prosocial behaviors (e.g., helping, leaving more generous tips; Cunningham, 1979; Guéguen and Lamy, 2013), while no studies have investigated potential temperature effects for positive political behaviors yet.

Excitation transfer theory (Zillmann, 2003) explains these divergent effects in terms of the arousal invoked by hot temperatures. Arousal involves the activation of the autonomic nervous and endocrine systems, leading to an increased heart rate and blood pressure and a condition of sensory alertness, mobility, and readiness to respond behaviorally. Specifically, the undesignated arousal created by high temperatures can be misattributed to another stimulus, which intensifies the individual's emotional response to this other stimulus (Zillmann, 2003). As a result, arousal makes negative experiences even more negative, as such facilitating aggression (Anderson and Bushman, 2002). Conversely, positive experiences become even more positive, which leads people to behave as good Samaritans and exemplary citizens (Foster et al., 1998).
As such, increases in arousal due to increases in temperature might impact the result of an election, because of its proposed impact on collective behaviors such as voter turnout. Such positive collective behavior, however, has received little to no empirical attention, and the present study helps to fill this gap in the literature by investigating the relation between temperatures and voting behavior. Excitation transfer theory predicts that heat increases arousal, and that this arousal mobilizes people to take action — including political action such as voting. This study investigated how changes in temperature (rather than absolute temperature) relate to changes in voting behavior. For example, an absolute temperature of 30°C (86°F) is a normal temperature in California, but is very hot in Alaska. Moreover, absolute temperature is related to many other variables confounded with temperature. For example, poverty is generally higher in countries with hotter climates. Hence, by studying change variables within geographically defined entities, the variation between these entities on a number of confounding variables is minimized.

THE PRESENT STUDY

We analyzed the relationship between temperature and voting using data from presidential elections from 1960 to 2016 in each state in the United States. In addition to mere voter turnout, this study also investigated how hot temperatures may pose costs as well as benefits for different political parties. Specifically, previous studies have found that hot temperatures increase anger (Anderson and Bushman, 2002; Bushman et al., 2005), which, in turn, motivates people to vote (Valentino et al., 2011; Van Zomeren, 2016). We predicted that such non-rational influence costs more votes for the incumbent party than for alternative parties. When people are angry with the current state of the country, they may choose to vote for a new candidate who promises a change. For example, one study found that parties that emphasize system change are especially likely to benefit from anger-based voting (Van Zomeren et al., 2016). In contrast, temperature-related positive emotions should gain more votes for the incumbent party than for alternative parties because people are happy with the current state of the country. For example, one study found that citizens who were interviewed on sunny days reported the highest levels of satisfaction with democracy, the government, and the economy (Mutz and Kampfer, 2011).

METHODS

We collected data from United States presidential elections from 1960 to 2016 in each state (and in Washington, DC, United States). We chose 1960 as the starting date because only from 1960 onward voter turnout per state was electronically available.

The temperature data were retrieved from the web application of the National Centers for Environmental Information. We selected a weather station close to the center of population for each state. Moreover, the selected stations should have data that go back to 1960 and should have a high degree of coverage, i.e., few missing data. In case of missing data, we sought the nearest station, and in all these cases data was available from a neighboring station within a close distance. Not only maximum temperature on Election Day was retrieved, but also the maximum temperature of the 7 days preceding the elections was collected, and we calculated the relative change with regards to the previous Election Day. A full description of the multilevel methods and assessment in state level temperature changes can be found in the Supplementary Materials.

Note that some election studies used more fine-grained geographical entities such as the county or municipality level to analyze the effects of precipitation, which is warranted because precipitation may show much local variation. On the other hand, temperature (and changes herein) is rather stable (e.g., Kusuda and Achenbach, 1965), and the inclusion of more fine-grained entities would unnecessarily inflate the effect of geographical entity. As most election studies with American samples (e.g., Gey, 2006), voter turnout was calculated by the following formula: 100% – [(Voting Age Population [VAP] – number of votes)/VAP].

The study included 761 data points. Multilevel modeling (MLM) with election dates (individual level) nested within states (contextual level) was conducted. A random intercept model that allowed intercept coefficients to vary across states was used (Raudenbush and Bryk, 2002). We constructed four similar models, one for predicting change in voter turnout, and three for changes in votes for the non-system parties (i.e., Greens, Independents, Libertarians), the challenger party (when a Democrat president has been in office during the last 4 years, the Republican party is the challenger party, and vice versa), and the incumbent party. We controlled for nine variables relevant to voting behavior (see also Curriero et al., 2002): (1) latitude and (2) longitude of the most populated area of each state, (3) maximum temperature on Election Day, (4) mean temperature the week before Election Day, (5) the president being available for reappointment, (6) the incumbent president being elected or not (Presidents Lyndon Johnson and Gerald Ford were vice presidents), (7) presidential approval ratings, (8) whether the president’s party had a majority in Congress during the two last years, and (9) change in state gross domestic product (GDP). A full description of and justification for these control variables can be found in the Supplementary Materials.

RESULTS

In the model predicting voter turnout, we included the control variables in the first block and added change in temperature compared to the previous election in the second block. In the models predicting change in voting results, we constructed similar multilevel models but added change voter turnout in the third block. Table 1 shows the unstandardized estimates of
the multilevel regression analyses on the respective outcomes when no control variables were included. As can be seen in Tables 2, 3, relationships remained significant even when control variables were included. A positive change in temperature on Election Day remained significantly related to an increase in voter turnout. For each increase of 1°C (1.8°F), voter turnout increased by 0.14%.

Tables 2, 3 also reveal that changes in temperature were related to both voter turnout and voting results. We therefore used bootstrap analyses (50,000 bootstrap samples) to decompose the total temperature effect into an indirect effect of temperature through voter turnout on voting result, as well as a direct effect of temperature on voting result. This analysis revealed significant indirect effects that corroborate the hypothesis that temperature-based increases in turnout are modulated by the context, and explains why voter turnout is facilitated in the context of high profile presidential elections, whereas aggressive behaviors are facilitated in the context of mass protest and revolt.

Moreover, the significant indirect effect of change in temperature via voter turnout on voting results hints at the possibility that anger is also involved in voting behavior, though future studies are needed to fully take into account the role of anger and other emotions. In this respect, it is noteworthy that smaller, non-system parties gain votes whereas the challenger, mainstream party does not (Van Zomeren et al., 2016). However, increased temperatures are unlikely to lead to system

### DISCUSSION

Previous studies have shown that hot temperatures are related to negative collective behavior (Lombroso, 1911; Schwartz, 1968; Carlsmith and Anderson, 1979), whereas the present study offers a first demonstration in the literature that changes in temperature are related to positive collective behavior (i.e., an increase in democratic and non-violent political behavior in the form of voter turnout). This result adds to the literature as former studies exclusively investigated temperature effects on violent mass behavior (Lombroso, 1911; Schwartz, 1968; Carlsmith and Anderson, 1979). This result is also in line with excitation transfer theory (Zillmann, 2003), which holds that temperature effects are modulated by the context, and explains why voter turnout is facilitated in the context of high profile presidential elections, whereas aggressive behaviors are facilitated in the context of mass protest and revolt.

3 In the American National Election Studies (ANES) datasets, a single-item measure of angry feelings toward the incumbent president was administered from 1980 onward (but not always in each state). We aggregated the available individual-level data into a state-level measure of anger per election year (N = 248 data points, i.e., 33% of our original dataset), and then calculated the relative change. Increases in anger correlated with increases in voter turnout, increases in votes for the challenger party, and decreases in votes for the incumbent party. Moreover, the effects of voter turnout on voting behavior dropped considerably once anger was taken into account, signifying that at least part of its effects can be explained by anger. The full results of these analyses can be found in the Supplementary Materials.

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TABLE 3 | Unstandardized estimates (standard errors in parentheses) of multilevel hierarchical regression analyses on change in votes for alternative parties (independent, libertarians, greens), the challenger mainstream party and the incumbent party.

| Non-system parties | Challenger mainstream party | Incumbent party |
|--------------------|---------------------------|----------------|
|                     | Step 1 | Step 2 | Step 3 | Step 1 | Step 2 | Step 3 | Step 1 | Step 2 | Step 3 |
| b (SE)              |        |        |        | b (SE) |        |        | b (SE) |        |        |
| Latitude            | 0.34   | -0.34  | -0.34  | 0.04   | 0.04   | 0.04   | -0.03  | -0.03  | -0.03  |
| Longitude           | 0.01   | 0.01   | 0.01   | 0.02   | 0.02   | 0.02   | 0.00   | 0.00   | 0.00   |
| Temperature Election Day | 0.25 | 0.22  | -0.22  | 0.01   | 0.01   | 0.01   | 0.00   | 0.00   | 0.00   |
| Temperature week before | -0.03 | -0.26 | 0.43  | 0.43   | 0.43   | 0.43   | 0.00   | 0.00   | 0.00   |
| President eligible for reappointment | 1.70  | -1.80 | 2.55  | 2.55   | 2.55   | 2.55   | 0.00   | 0.00   | 0.00   |
| President elected | 0.22  | 0.51  | 0.48  | 2.82   | 2.83   | 2.83   | 0.00   | 0.00   | 0.00   |
| Approval rating | -0.29  | -0.28 | -0.28  | -0.28  | -0.28  | -0.28  | -0.28  | -0.28  | -0.28  |
| Majority in Congress | -0.50 | -0.50 | -0.50  | -0.50  | -0.50  | -0.50  | -0.50  | -0.50  | -0.50  |
| Δ Temperature on Election Day | -4.20 | 4.17  | -4.17  | -4.17  | -4.17  | -4.17  | -4.17  | -4.17  | -4.17  |
| Δ Voter turnout | 6.37** | 3.75** | 3.75** | 6.37** | 3.75** | 3.75** | 6.37** | 3.75** | 3.75** |

GDP, gross domestic product; $p < 0.05, \text{ one tailed; } p < 0.01, \text{ two tailed}.$
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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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