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Temper, Temperature, and Temptation: Heat-Related Retaliation in Baseball

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Abstract

In this study, we analyzed data from 57,293 Major League Baseball games to test whether high temperatures interact with provocation to increase the likelihood that batters will be hit by a pitch. Controlling for a number of other variables, we conducted analyses showing that the probability of a pitcher hitting a batter increases sharply at high temperatures when more of the pitcher's teammates have been hit by the opposing team earlier in the game. We suggest that high temperatures increase retaliation by increasing hostile attributions when teammates are hit by a pitch and by lowering inhibitions against retaliation.

Keywords

aggression, baseball, heat, justice, retaliation, temperature, violence

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> "There are so many conflicting emotions," [St. Louis Cardinals manager Tony La Russa] says, when your batter gets hit. Because how do you sort it out? How do you know for sure that the pitcher acted intentionally? (Bissinger, 2005, p. 111)

Decades of research have shown that hotter temperatures are associated with greater aggression in the laboratory (Anderson, Anderson, Dorr, DeNeve, & Flanagan, 2000) and with higher rates of violent crime in the field (Anderson, 1989; Cohn & Rotton, 1997; Rotton & Cohn, 2004). Previous field research has shown that batters are more likely to be hit by a pitch in Major League Baseball (MLB) games on hot days than on cool days (Reifman, Larrick, & Fein, 1991). In this study, we examined a specific mechanism linking heat to aggression in baseball. We found that hotter temperatures have only a modest direct relationship to higher aggression. However, heat appears to magnify the response to provocation: Heat predicts retribution.

The Decision to Retaliate

There is a long-standing tradition of retributive justice in baseball. If a teammate is hit by a pitch, a player on the opposing team must be hit in return (Turbow & Duca, 2010). This Hammurabi code of a "batter for a batter" (Bissinger, 2005, p. 112) serves both to restore justice and to deter future harm. Previous research has found empirical support for retaliatory behavior in baseball (Timmerman, 2007). However, there are constraints on this practice. Because it is dangerous to strike a batter with a ball traveling at 90 mph, MLB has taken strong steps to punish this behavior (Bradbury & Drinen, 2007; Trandel, 2004). It is also costly to a team to hit an opposing team's batter. Because hit batters are sent to first base, hitting them prolongs an inning and increases the chances that the opponent will score. Thus, the decision to retaliate is a difficult one.

In the statement quoted at the beginning of this article, La Russa suggested that an important factor in the decision to retaliate is determining whether the opposing pitcher acted intentionally. The norm is that an intentional harm is more deserving of retaliation than is an accident. But the evidence for intention is almost always ambiguous—was a pitcher sloppy or aggressive? Sometimes this ambiguity will be resolved in a charitable way ("it was an accident"), thereby de-escalating conflict (Rubin, Pruitt, & Kim, 1994). However, some factors, such as high temperature, may heighten perceptions of malicious intent and loosen inhibitions restraining

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retaliatory aggression. Our key empirical prediction was that temperature amplifies the tendency to retaliate when a teammate is hit by a pitch.

Heat and Provocation

In their general-aggression model, Anderson and Bushman (2002) proposed three routes by which temperature can lead to aggression: affect, arousal, and cognition. Laboratory studies have shown that high temperatures influence behavior through affective aggression and arousal (Anderson, Anderson, & Deuser, 1996; Anderson et al., 2000; Anderson & Bushman, 2002; Anderson, Deuser, & DeNeve, 1995).[1] Conversely, aggression cues (e.g., images of weapons) influence behavior through cognition. Anderson et al. (1995) proposed that the internal states of affect, arousal, and cognition are likely to have interactive effects if they are all triggered at once.

We predicted that temperature interacts with an aggression cue to increase aggressive behavior. Although we could not directly test intervening psychological steps, we propose two processes that could plausibly give rise to an interaction between temperature and provocation. Specifically, retaliatory behavior might be increased when a teammate is hit by a pitch if temperature alters (a) the interpretation of the ambiguous aggression cue or (b) the assessment of the appropriate response to that cue. Laboratory experiments have shown that heat increases state hostility (anger) as well as other forms of negative affect (Anderson et al., 2000). As Anderson and Bushman (2002) argued, anger "is used as an information cue . . . . If anger is triggered in an ambiguous social situation, the anger experience itself helps resolve the ambiguities, and does so in the direction of hostile interpretations" (p. 45; see also Zillman, Katcher, & Milavsky, 1972).

We surmised that two processes might link temperature to aggression in baseball. First, heat-induced anger would increase the chances that an ambiguous cue—a hit teammate—is appraised as an intentional, provocative act. Second, heat-induced anger would also make retaliation more likely because anger primes aggressive scripts (Anderson & Bushman, 2002). Specifically, heat-induced anger may make the Hammurabi code of "a batter for a batter" more cognitively accessible. Our main testable hypothesis was that higher temperature would interact with more hit batters on a pitcher's team to increase the probability that the pitcher would hit one of the opposing team's batters with a pitched ball.

In addition to testing our main hypothesis, we examined two other relationships. First, we tested whether retaliation was related to how many batters the pitching team previously hit during the same game. This variable, and its interactions, helped us assess the degree to which teams kept count of how many of their batters had been hit and limited retaliation when they or their opponent evened the number of hit batters (Axelrod, 1984). Second, we tested both a linear and a quadratic relationship between temperature and retaliations. Bell's (1992) observation that there is a "heated debate" (p. 342) about the functional relationship between temperature and aggression remains true today (Bell, 2005; Bushman, Wang, & Anderson, 2005; Cohn & Rotton, 2005). The negative-affect-escape model (Anderson, 1989; Baron & Bell, 1975; Bell, 1992; Cohn & Rotton, 1997; Rotton & Cohn, 2000, 2004) proposes that heat-induced negative affect leads people to escape the heat, thereby decreasing opportunities for outdoor aggression. Field research has found an inverted-U relation between temperature and different forms of aggression, such as outdoor crimes (Rotton & Cohn, 2004). In baseball, the act of hitting a batter prolongs an inning and delays a pitcher's chance to leave the mound. We tested whether a pitcher is more likely to escape the heat or to retaliate at extreme temperatures by testing both quadratic and linear terms.[2]

The analysis conducted by Reifman et al. (1991) could not test for patterns of retaliation because it examined only game-level data (i.e., total number of batters hit by pitches summed across teams). A more direct test of whether pitches that hit batters are an act of aggression is to examine whether incidents of retaliatory pitches increase with temperature. A test of retaliation patterns requires examining data at the team or individual level (Timmerman, 2007).

Method

To test the relationship between temperature and retaliation, we downloaded event files with play-by-play data from the Web site Retrosheet (n.d.). These data were ideal for testing our hypothesis because each batter's appearance is recorded as a separate record in the database. In fall 2009, Retrosheet's archive included 111,048 MLB games played from 1952 through the end of 2009. Separate game logs available from Retrosheet contained the game-time temperature for 57,293 of these games. (Inside temperatures were recorded for domed stadiums.) Merging these two data sources provided game-level data (e.g., temperature, attendance) and situational data (e.g., game score during the batter's appearance) for 4,566,468 pitcher-batter matchups (known officially as *plate appearances*).

Because the pitcher-batter matchups were nested within games and therefore likely correlated, we used generalized estimating equations to analyze the data. These equations provide parameter estimates and standard errors that are efficient and unbiased for analyzing correlated binary responses (Ballinger, 2004). The binary response in this case was whether or not a batter was hit. In addition, we controlled for situational variables that might also contribute to rates of batters being hit by pitches. Reifman et al. (1991) reasoned that hot days may simply make a pitcher less accurate than normal—perhaps because of fatigue or a slippery hand—and they addressed this possibility by including indicators of inaccuracy (e.g., walks and wild pitches) as control variables. We also included proxies for pitcher inaccuracy in our analysis. Table 1 presents the full set of control variables and the justifications for their inclusion in the analysis.

Table 1. Game and Situational Variables Used to Predict Batters Being Hit by a Pitch

Variable	Level	*M*	*SD*	Range	Justification for inclusion in the analysis
Year	G	1994.36	12.22	1952–2009	Incidences of batters hit by pitches have increased over time (Trandel, 2004)
Attendance (in thousands)	G	27.09	12.59	0.41–78.67	Important games may evoke greater competitiveness
Designated hitter used (0 = no; 1 = yes)	G	.49	.50	0–1	Designated hitters increase the likelihood of batters being hit by a pitch because pitchers are protected from retaliation (Bradbury & Drinen, 2007)
Game played in the southern United States (0 = no; 1 = yes)	G	.17	.38	0–1	Games played in the South may evoke culture of honor
Inning (1–9)	P	5.01	2.67	1–22	Proxy for other game events that vary with time
Hits allowed by pitcher	P	2.28	2.27	0–16	Proxy for pitcher inaccuracy and frustration
Home runs allowed by pitcher	P	0.22	0.50	0–6	Proxy for pitcher inaccuracy and frustration
Walks allowed by pitcher	P	0.78	1.06	0–12	Proxy for pitcher inaccuracy and frustration
Wild pitches thrown by pitcher	P	0.07	0.27	0–4	Proxy for pitcher inaccuracy
Errors by pitcher's team	P	0.11	0.34	0–5	Proxy for general inaccuracy
Score difference (own team minus opposing team)	P	−0.03	3.13	−22–22	Higher difference between the pitcher's team's score and the batter's team's score makes hitting a batter less costly
Teammates hit by opposing team	P	0.15	0.41	0–5	More teammates hit should increase retaliation
Temperature (°F at game time)	G	72.72	10.92	26–109	Heat should increase aggression

Note: G = game-level statistic (value for whole game); P = plate-appearance-level statistic (value at time of plate appearance).

Results

As predicted, there was a significant interaction between temperature and the number of teammates hit by the opposing pitchers (see Table 2). We plotted the interaction in Figure 1, which shows the expected probability of a pitcher hitting a batter as a function of temperature and the number of the pitcher's teammates hit by the opposing team earlier in a game.[3] The results show a clear pattern. The probability of a pitcher hitting a batter is weakly related to temperature at times when the opposing team has not hit any of the pitcher's teammates; however, the probability of hitting a batter increases sharply with temperature as the number of hit teammates increases.

We performed two additional tests. First, we tested whether the probability of a pitcher hitting a batter was related to how many batters the pitching team previously hit during the same game. This variable did not have a significant effect, nor did it interact with either temperature or number of hit teammates. These results suggest that retaliation does not depend on the number of batters hit on one team relative to the other (Axelrod, 1984)—the driver of retaliation was simply the interaction of temperature with the number of teammates hit by opposing pitchers earlier in the game. Second, we created a quadratic term for temperature and found that neither it nor its interaction with hit teammates was a significant predictor of the likelihood of a batter being hit. One explanation for finding just a linear effect is that enforcing the norm of retaliation is more important than escaping from the situation. A more general explanation is that the obligation of pitching makes extended exposure to heat unavoidable. In crime data, the incidence of outdoor crime drops at high temperatures because potential offenders avoid being outside (Bell, 1992; Rotton & Cohn, 2004). Pitchers cannot avoid their job in high heat.[4]

Discussion

In an analysis of more than 57,000 MLB games, we found that higher temperatures interacted with a greater number of teammates being hit by a pitch to increase the chances of a pitcher subsequently hitting an opposing batter. This pattern held even when we controlled for a number of other influences on batters being hit by a pitch. We believe that the most plausible explanation for this pattern is that heat increases anger and arousal, and this psychological state changes how pitchers interpret and respond to provocation. The pattern clearly suggests that hitting batters with pitches is an act of aggression and not simply an accident of heat-induced inaccuracy.

The spreading interaction depicted in Figure 1 shows that the probability of a pitcher hitting a batter is a function of both temperature and provocation. When none of a pitcher's teammates has been hit by a pitch, the probability that the pitcher will hit an opposing batter is only weakly related to temperature. The probability that the pitcher will hit a batter increases

Table 2. Generalized Estimating Equations Predicting the Per-Plate-Appearance Probability of a Batter Being Hit by a Pitch From Game and Situational Variables

Predictor	*b*	*SE b*
Year	0.019***	0.0005
Attendance (in thousands)	0.002**	0.0005
Designated hitter used	−0.001	0.0110
Game played in the southern United States	0.041**	0.0145
Inning	−0.004	0.0021
Hits allowed by pitcher	−0.012***	0.0029
Home runs allowed by pitcher	−0.006	0.0121
Walks allowed by pitcher	0.004	0.0057
Wild pitches thrown by pitcher	−0.024	0.0214
Errors by pitcher's team	−0.037*	0.0173
Score difference (own team minus opposing team)	0.031***	0.0018
Teammates hit by opposing team	−0.158	0.0885
Temperature	0.001*	0.0006
Temperature × Teammates Hit by Opposing Team	0.004**	0.0012
Constant	−42.797***	1.0922

Note: N = 4,566,468 plate appearances within 57,293 games.
*p < .05. **p < .01. ***p < .001.

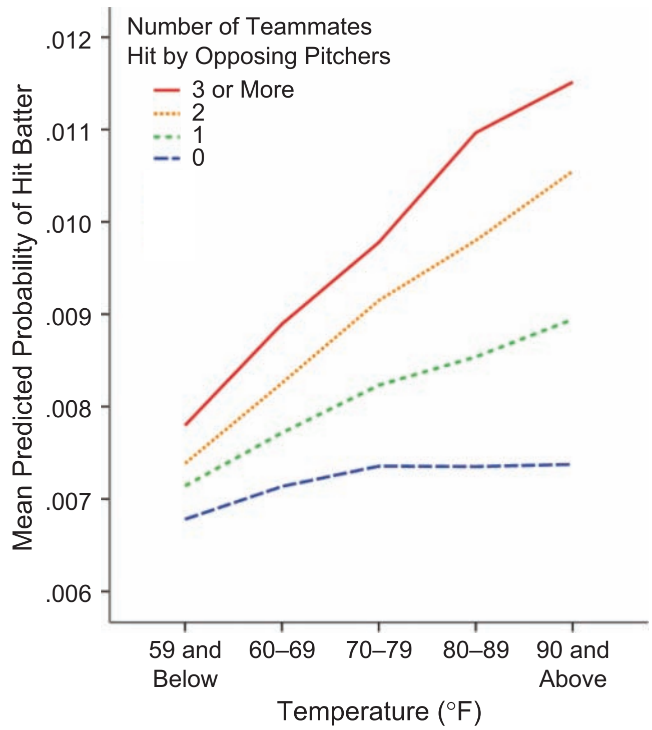

Fig. 1. Predicted probability of a batter being hit as a function of temperature and the number of the pitcher's teammates hit by the opposing team's pitcher earlier in a game.

at higher temperatures if more of the pitcher's teammates have been hit earlier in the game. Thus, during an otherwise identical event—a pitcher's teammate is hit by a pitch in the first inning—the probability that the pitcher will hit a batter on the opposing team later in the game increases from roughly .22 when the temperature is 55 °F to .27 when it is 95 °F.[5]

It is tempting to believe that retaliation is a crime of passion. More precisely, retaliation seems like a form of affective aggression—which is immediate, emotional, and automatic—and not a form of instrumental aggression—which is more deliberate (Geen, 2001). Although a batter charging the mound after being hit by a pitch may be driven by affective aggression, this explanation is less plausible for a pitcher hitting a batter. Retaliation by a pitcher occurs one or more innings after an offense, and a typical time lapse between innings is 15 min. In all likelihood, retaliatory pitches are an example of a mixed-motive reaction (Anderson & Bushman, 2002), in which anger and calculation (including group deliberation) fuel the decision to retaliate.

Using field data to examine the relationship between heat and aggression has both limitations and benefits. We have posited two processes by which heat might lead an ambiguous event—a teammate being hit by a pitch—to provoke an aggressive response. One process is a tendency to make increasingly hostile interpretations; the other process is an increased likelihood of invoking an aggression script. A limitation of the current research is that we could not examine the direct influence of either process with our data. Carefully designed experiments, however, could examine the influence of each process.

A limitation of laboratory studies, however, is that the outcomes of extended interactions may be missed. Anderson et al. (2000) provided an interesting example of this problem. In reviewing the theoretical explanations for heat-induced aggression, they noted that one theory—the social-justice model—predicts higher levels of initial aggression after a provocation but lower levels at later points in time because the motive for retribution has been satisfied. This pattern has received empirical support in the laboratory (Anderson et al. 2000). However, Anderson et al. noted that this laboratory pattern may not generalize to interactions that unfold over time. In extended interactions, retaliation for an offense can provoke further retaliation (Luckenbill, 1977). That is, although one side in a conflict may think it has settled an old account through an aggressive act, the other side may perceive the aggression as opening a new account that then needs to be settled (Kahn & Kramer, 1990; Keysar, Converse, Wang, & Epley, 2008). We believe that the increased degree of retaliation at high temperatures in baseball illustrates the role that temperature can play in exacerbating conflict.

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Declaration of Conflicting Interests

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

Notes

1. Uncomfortably cold temperatures have been shown to increase aggression in laboratory studies but not in field studies. As Anderson et al. (2000) stated, "There is one simple explanation [for this phenomenon]. People and societies are generally better at reducing cold discomfort (via clothing, heating) than they are at reducing heat discomfort" (p. 93).
2. Other factors complicate the identification of the functional relationship between heat and aggression in field studies; these factors include the relationships among temperature, time of day, and choice of activity at that time of day (Bell, 1992; Rotton & Cohn, 2004). Using MLB games allowed us to test this functional relationship without these complicating factors.
3. Figure 1 is based on plotting the predicted values for the actual cases in the data (Hoetker, 2007). Specifically, the regression model was used to calculate a predicted probability of a hit batter for each case as a function of its values for the variables in the model. The predicted values were then grouped by temperature level and number of teammates hit by the opposing team. This procedure yielded a final value based on representative cases.
4. Timmerman (2007) has shown that pitchers born in the U.S. South are more likely than others to retaliate when their teammates are hit by a pitch. We tested whether temperature remained a key variable after controlling for three measures of southernness: the location of the game, birthplace of the pitcher, and home location of each team. Only one southernness variable had a significant effect (see Table 2): Playing games in the southern United States increased the probability of a pitcher hitting a batter. This result suggests that a subculture difference (Nisbett & Cohen, 1996)—perhaps fan expectations—contributes to pitchers' aggressiveness.
5. The probability per plate appearance of hitting a batter after one teammate has been hit is roughly .007 at 55 °F and .009 at 95 °F. Assuming that there are 35 more plate appearances after the first inning, the chance of not hitting a batter during the rest of the game would be .78 in the former case, $(1 - .007)^{35}$, and .73 in the latter case, $(1 - .009)^{35}$. The corresponding chances of hitting a batter would be .22 and .27, respectively.

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