Emotions and Institutional Constraints: A Demonstration Case of Temperature and Insurgent Violence

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Theorists and practitioners of war have long understood acts of violence as jointly motivated by the fighting institution's strategic calculations and by the individual combatant's emotions. The combination of empirical barriers and the theoretical assumptions of rational choice theories have hindered observational research on their joint role in producing violence. Leveraging the established phenomenon of ambient temperature's influence on human aggression, we demonstrate that during the Afghanistan and Iraq wars temperature exercised three substantively large and non-strategic effects on the attitudes and behaviors of conflict participants. Temperature affected the type and intensity of insurgent attacks, the odds of insurgent fatalities during skirmishes, and the willingness of military-age men to endorse violence against international forces. The results suggest that theories of political violence that disregard the influence of emotion are limited in their ability to explain conflict outcomes. The article publishes the U.S. Department of Defense's full and official record of Iraq War

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insurgent violence directed against international and government forces.

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Even if brought about by cold strategic calculation, military combat is an emotional event. Clausewitz articulated this duality as the difference between hostile feelings experienced by warriors and their political leadership's hostile intentions, devoting his studies to the latter (Von Clausewitz et al. 2011: p. 137-8). Contemporary conflict research maintains this emphasis, illuminating the causes and consequences of war with reference to the combatants' strategic incentives.

Recent studies have deepened our understanding of the dynamics of war by treating combatants as non-emotional actors producing optimal quantities of violence that further their broader strategic goals. The evident effort by political institutions to mobilize their fighters' violence toward their strategic objectives makes this a reasonable assumption (Grossman 2014). An officer corps is tasked with the "management of violence." These officers ensure that the type, target, and frequency of violence is optimized for strategic ends (Huntington 1957: p. 13). Non-state groups similarly manage their production of violence (Shapiro 2013). Even if some fighters deviate on the margins, institutions on the whole direct their actions to fulfill the strategic interests of the political organizations. As a result, rationality can be imputed as a net and aggregate effect in which idiosyncratic behaviors grounded in emotion disappear into the error term.

Social research in non-conflict settings suggests in contrast that human behavior is never free of emotional influences. Studies of the effects of individuals' emotional states on their judgments and decision making provide evidence that emotional stimuli are both more pervasive than believed and influence individuals without conscious awareness. Emotional factors appear in "least likely" domains, as when local weather affects stock prices (Saunders 1993). Despite strong economic incentives to make purely instrumental decisions, the psychological effects of weather in part determined traders' behavior. These empirical descriptions offer grounds for interrogating the sanitized rational choice logic, raising questions about the actual success of violent political organizations in translating their strategic objectives into their fighters' actions.

The answers matter most for theories that permit the least deviation from the as-if-rational assumption. For a rational choice theory of political violence to retain its explanatory power, individual idiosyncrasies or passing emotional states of the critical decision makers must be peripheral to the outcome. When they describe knife-edge equilibria, theories of strategic interaction are especially vulnerable to individual outlier behavior out of step with institutional strategy. Proponents of rational choice models recognize that they are ill-suited for "actions taken in non-iterative situations by individual decision makers (such as in crisis situations)" (Tsebelis 1990: p. 38). But emotions do not have to act on individuals occupying high offices to influence conflict outcomes. If particular emotions systematically shape the judgments and behaviors of many conflict participants, they would have large effects indiscernible to empirical research in a rational choice framework.[1]

The main barrier to research that accounts for both emotional and strategic factors has been empirical: "scholars lack microlevel data to see the operation of these emotional influences, thereby forcing them to make inferences from highly aggregated phenomena" (McDoom 2012: p. 129-30). Equipped with fine-grained conflict data recorded during the recent Afghanistan and Iraq wars, we can now test whether emotional influences on individual fighters have shaped the conflicts' patterns of violence.

Ensuring that the link between the emotional cause and its behavioral effect is not strategic requires precise measurements and a robust identification strategy. Direct evidence for the effect of emotion on combat patterns also requires an emotion incidental to the strategic objectives of individual combatants' behaviors. Should the variable affect the strategic

[1]Emotion experienced by an individual combatant does not inherently compete with the institutional strategy. For instance, an individual's desire for self-sacrificing heroism would be an emotional motivation for violence with strategic value for the institution.

choices of individual combatants, these must be identifiable so that the emotional influence can be isolated. Ambient temperature fulfills these criteria.

We present evidence that in recent U.S.-led counterinsurgent conflicts, ambient temperature affected: (1) how and when insurgents elected to initiate attacks, (2) their odds of incurring fatalities, and (3) combat-age males' support for violence. We first find that the less institutional control existed over weapons, the more responsive fighters were to the effects of ambient temperature. Next, we demonstrate that Taliban fighters in Afghanistan were more likely to perish in attacks they initiated at hotter temperatures with the least organizationally constrained weaponry. Insurgents were no more likely to die when they carried out attacks at higher temperatures unless they did so with weapons over which they exercised the greatest discretion. This pattern is evidence of spontaneous and strategically costly combatant behavior. Finally, we show that military-age Iraqi males' expressions of aggression varied with ambient temperature following the same pattern. At higher temperatures, surveyed citizens expressed greater support for violence against the country's multinational occupying forces.

These findings are based on the U.S. Defense Department's complete and official record of Iraq War insurgent violence committed against Iraqi, American, and other international forces. Although abridged versions of this dataset have been available, the complete war dataset had remained classified. Two other recent datasets provide further data for testing. First, we use the complete Afghanistan War dataset of insurgent violence released by Shaver and Wright (2016) to assess insurgent fatalities. Second, an Iraqi firm's monthly survey carried out throughout the conflict measures endorsement of violence. The survey elicited responses from some 175,000 Baghdad residents and was introduced before by Klor et al. (2016).

1.1 Emotional and Strategic Violence

The dominant current of recent sub-state conflict research treats both combatants and civilians as strategic actors, presuming that their actions reflect the pursuit of calculated political and military strategies. For instance, de Mesquita (2013) conceptualizes insurgents' choice of targets as a rational response to an insurgent organization's environment. An expansive catalogue of empirical evidence is consistent with these assumptions (Berman et al. 2011b). Kalyvas and Balcells find strategic and political motivations in violence against non-combatants in civil war settings (Kalyvas 1999; Kalyvas et al. 2006; Balcells 2011). Under this line of scholarship, any civilian harm inflicted by combatants that does not advance their strategic goals should be rare and unintentional. Explaining the choice to relegate emotion to the error term, Kalyvas argues that political and non-political violence are separate phenomena, in part because individuals "involved in the production of political violence appear to lack the kind of 'extreme' personality features that tend to correlate with expressive violence" (Kalyvas et al. 2006: p. 25).

The literature on terrorism has debated whether that form of political violence is a rational tactic in pursuit of strategic goals. One side holds that terrorist violence results from a rational calculation by political actors reacting to their strategic environment (Kydd and Walter 2006; Pape 2006). The opposing view proposes that terrorists depart "from narrow self-interest and rational expectations, and suicidal terrorists probably violate both" (Caplan 2006: p. 91). Psychologists studying former terrorists report that strong emotional components are integral to inflicting violence on non-combatants (Horgan 2004). The recent empirical sub-state conflict literature does not reflect these debates, fixating instead on strategic behavior (Humphreys and Weinstein 2008; Berman et al. 2011a,b; de Mesquita 2013; Shapiro and Weidmann 2015; Carter 2016).

When addressed in the study of violent political conflict, emotion has been invoked to explain errors and deviations from ostensibly *correct* or *rational* actions. Mercer (2005) proposes instead that *all* acts arise from a combination of emotional and cognitive sources. Some political scientists have embarked on empirical research programs that account for psychological biases, with a focus on the implication for the literature's rationality assumption (Sasley 2010; Ross 2013). McDermott (2004) argues that affective and strategic behavior sources are not zero sum: "emotion is part of rationality itself, and that the two are intimately intertwined and interconnected processes, psychologically and neurologically" (p. 693). Insofar as emotions have behavioral consequences in the realm of violence, they are the first reason to expect that not all political violence is purely instrumentally motivated.

Another integrative approach acknowledges that both emotion and strategy combine to produce the general preference structures within which human agents will seek to maximize their payoffs. For instance, Posen (1993) and Kalyvas (2003) argue that emotion-based grievances can motivate strategic behavior, as when individuals join groups for emotional reasons, then pursue the group's strategic goals with violent means.

While it would appear tempting to subsume all emotional variables in a cost or utility function, Petersen argues that emotions are not convertible to utility: "The emotion-based approach does not need to create these dubious rank-orderings. Emotions create a sense of urgency, they dramatically raise the salience of a particular desire, they explain compulsion. The trade-offs between revenge and self-esteem, for example, cannot be realistically calculated or represented with an indifference curve. In rational choice, the stability of preferences is a simplifying assumption. Most practitioners of rational choice would probably agree that this simplification is not always useful for every type of human behavior. " (Petersen 2002: p. 33)

A more promising approach is available. Evidence to support behavior-shaping emotional stimuli is well established in psychology. Renshon and Lerner (2012) distinguish between integral and incidental emotional drivers. We are interested in the latter, which are "normatively unrelated to the decision at hand [but] affect decision-making in critical and often unappreciated ways" (Renshon and Lerner 2012: p. 1). Incidental emotions influence individuals' behaviors non-consciously and is beyond the "control" of rational calculation (Lerner et al. 2015). The empirical evidence of this phenomenon is robust (Lerner et al. 2015; Schwarz and Clore 1983; Gallagher and Clore 1985; Lerner and Keltner 2000, 2001; Han et al. 2007; Bodenhausen 1993).

2 Incidental Emotion and Ambient Temperature

The effects of incidental emotion are hard to find in observational data. The literature's emphasis on strategic and tactical motivations stems from the difficulty of uncovering "with an acceptable level of accuracy the individual motives behind violent acts" (Greenstein and Polsby 1975: p. 75). Absent an ability to distinguish proportional emotional and strategic motivations for individual acts of violence, the literature has given combatants the benefit of the doubt and interpreted their behavior as manifestations of rational utility maximization. We propose instead that we can identify the role of incidental emotion in conflict by leveraging temperature's well-identified effects on human aggression.

In laboratory settings, hotter temperatures have produced increases in verbally reported hostile attitudes, impaired cognitive performance, and experience of negative emotional states (Anderson et al. 1995; Pilcher et al. 2002).[2] At elevated temperature ranges, Vrij et al. (1994a) show that police officers discharged more bullets in a shooting simulator, Nathan DeWall and Bushman (2009) find that subjects have aggressive thoughts, and Gockel et al. (2014a) conclude that they were more likely to judge a murderer's motive as an emotional impulse.[3]

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[2]Humans are not the only organisms that react violently to heat. In the marine environment, coral reef fish and sea turtles are more aggressive at higher temperatures (Biro et al. 2009).

[3]Multiple studies show that making affected individuals aware of the source of stimulation eliminates the effect. For example, Schwarz and Clore (1983) find that subjects report lower happiness on rainy days.

Crime records confirm the human tendency to behave more violently at higher temperatures, leaving "little doubt or controversy about the existence of a heat-violence relation in real-world data" (Anderson et al. 2000: p. 67). Psychologists, criminologists, sociologists, and other scholars have investigated this phenomenon for centuries (Anderson et al. 1997; Ranson 2012; Anderson 2001; Dodge and Lentzner 1980; Kenrick and MacFarlane 1986; Reifman et al. 1991; Gamble and Hess 2012; Rotton and Cohn 2000a, 2001; Pilcher et al. 2002; Vrij et al. 1994b; Nathan DeWall and Bushman 2009; Gockel et al. 2014b). Anderson et al. (1997) find that temperature is positively correlated with "serious and deadly assault even after time series, linear year, poverty, and population age effects were statistically controlled." Property crime, which is unrelated to ephemeral changes in aggressive tendencies, shows no such covariation with temperature.[4]

The resulting body of observational and experimental evidence points to a causal effect that is statistically significant, substantively large, and expected to take a specified nonlinear functional form.[5] The temperature-conflict relationship has been identified at many points on a spectrum that spans spontaneous violence between individuals up to organized group violence. In sum, the overwhelming evidence holds that individuals will be more violent at

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Those who were either directly reminded that weather can affect mood or indirectly primed by being asked about their local weather did not report lower life satisfaction. These reminders are uncommon, leaving human behavior sensitive to emotional stimuli. Research on the effects of temperature on aggression finds the same. For instance, Palamarek and Rule (1979) show in an experiment that subjects who were more aggressive at higher ambient temperatures became less so once they noticed the temperature.

[4]Ranson (2012) concurs, demonstrating that the effect is immediate. Studies that "measure temperature at the exact time that aggressive behaviors occurred" corroborate earlier findings by Anderson (2001) that temperature "has a strong positive effect on criminal behavior, with little evidence of lagged impacts."

[5]Disagreement persists over the functional form of the temperature-violence relationship. Gamble and Hess (2012) conclude that "daily mean ambient temperature is related in a curvilinear fashion to daily rates of violent crime with a positive and increasing relationship between temperature and aggravated crime that moderates beyond temperatures of 80°F and then turns negative beyond 90°F." The main arguments over the functional form are found in Cohn and Rotton (1997), Rotton and Cohn (2000a), Rotton and Cohn (2001), Anderson et al. (2000), and Anderson and Anderson (1984). The linear findings were likely an artifact of studying environments that do not reach sufficiently high temperatures to induce a reduction in violence. Heat abounds in Iraq and Afghanistan.

certain temperature ranges.

This makes ambient temperature a pure incidental emotional motivation for violence distinguishable from strategic behavior in observational conflict data. Of the known emotional sources of violence, temperature also offers several methodological and empirical advantages for testing in wartime. First, combatants are invariably exposed to fluctuating temperature. The vast majority of fighting in wars occurs outdoors even if electric cooling places some commanders in different temperatures. Second, reverse causality in statistical testing is impossible. Third, temperature has been precisely recorded in many conflicts. Fourth, it varies significantly over time.

3 Research Design

The research design tests whether emotions systematically limit rational choice explanations. As a class, emotions remain difficult to measure in observational data. Emotions integral to an experience are especially difficult to disentangle from non-emotional motivations. Incidental emotions, on the other hand, provoke behavior exogenously. This makes them empirically distinguishable from other determinates of behavior, including institutional constraints and integral emotions.

We therefore isolate an incidental emotional effect exerted exogenously on individual combatants: ambient temperature. As an independent effect from integral and institutional constraints, it pits incidental emotion against the strategic calculations of the institutions in which they are embedded.

Fine-grained, voluminous, and geo-referenced data on combatant and civilian judgments and behavior generated throughout the US-led counterinsurgent wars in Afghanistan and Iraq makes it possible to measure the effect of a reliable source of incidental emotion. We exploit several characteristics central to how insurgents fought and variation in specific characteristics from these conflicts. To increase confidence in a causal interpretation of our findings, we test our theoretical assumptions across distinct contexts and with different units of analysis to limit the possibility that any single unobserved variable influences our results.

If combatants' incidental emotion shapes conflicts, several hypotheses should be confirmed in conflict data about three dependent variables: attack frequency, insurgent fatalities, and civilian support for violence.

Attack frequency. Prior empirical findings provide a clear expectation of the effects of temperature on the production of violence. First, we verify a relationship between ambient temperature and insurgent violence consistent with a causal effect of temperature on violence mediated through a psychological response in two ways. This first set of verification tests involve analyzing the temperature-violence relationship regarding the type of attack. The second set relates to the attack's timing.

The relationship is conditional on their operations not being controlled by high-level commanders. Only attack types over which individual insurgent combatants have discretion involve more insurgent casualties under conditions of higher temperatures. Insurgent casualties associated with attack types over which insurgent combatants do not have discretion do not vary with temperature. Attack frequency outcomes might correlate with temperature for strategic reasons not related to incidental emotions. We test for these alternative explanations.

Insurgent fatalities. Next, we test whether insurgent attacks undertaken at higher temperatures during the ongoing Afghanistan conflict have been more likely to result in battlefield fatalities for their perpetrators than those undertaken at cooler temperatures. This outcome is expected if insurgents' use of violence at higher temperatures follows aggressive rather than strategic impulse. That is, if individuals accept greater risk.

Decisions to attack with–and only with–the least institutionally constrained weaponry at higher temperatures should generate greater costs. We assess the risk in terms of insurgent fatalities incurred in attacks on international forces. Only attack types over which insurgents exercise individual autonomy are more likely to increase insurgent fatalities when carried out at higher ambient temperatures. Confirmation would make it less likely that the relationship between attack frequency and temperature results from hidden tactical dynamics.

Civilian support for violence. Individual aggressions connects the temperature-violence causal link. We can assess this proposition through the endorsement of violence and temperature in surveys of civilians. Individual expressions of hostility should vary with ambient temperature in patterns like combatant behavior. A concordance between the insurgent behavior and the public opinion polls would show that both the public and combatants are deriving individual-level benefits from engaging in violent behavior at certain temperature ranges.

To test the incidental emotion mechanism, a third set of tests confirm that a temperature-aggression relationship manifests attitudinally in a conflict setting by measuring ambient temperature and attitudes toward violence among combat-age males in Baghdad during the recent Iraq War. The strategic choice considerations which we would expect to influence an insurgent's judgments of the costs and benefits of an attack are not affecting public opinion poll answers. Survey respondents did not have to consider the costs of fighting, the risk of death, or the strategic choices of the U.S. All that is being influenced is how the temperature affects their pro-violence tendencies.

3.1 Attack frequency

Paired with data on temperature and relevant covariates, detailed information collected by U.S. forces during the recent Afghanistan and Iraq wars provide an opportunity to test hypotheses. Covariation in daily insurgent violence and temperature levels can be evaluated to determine whether insurgents undertake more attacks on hotter or cooler days. If so, we can establish the relationship's estimated functional form. The extant literature remains divided over whether violence displays decreasing returns to temperature above a threshold. Laboratory and observational data about this relationship cluster at an inflection point of around 90° Fahrenheit.

3.1.1 Attack frequency by type

Strategic considerations can moderate aggressive tendencies provoked by specific temperatures. When carrying out attacks that are closely directed by senior combatants, for instance with predetermined targets and dates, insurgents should show little or no response to temperature. On the other hand, attack types that leave decisions such as when and how intensely to engage enemy targets to individual fighters should vary with temperature.

Whether attacks over which individual combatants exercise significant discretion vary with temperature while those subject to organizational constraints do not can be identified by exploiting variation in daily temperature and insurgent attacks in which specific weapons are employed. Weapons used by insurgents in Afghanistan and Iraq wars varied in their characteristics. They can be divided into two general classes.

The first class is highly mobile weaponry, subject to the fewest institutional constraints. Insurgents enjoyed significant discretion in discharging these weapons, which are designed to be fired by a single individual. Small arms like pistols and automatic and rifles, which can be rapidly and repeatedly directed against both stationary and mobile targets, belong to this class. [6] If temperature influences individual combatants, temperature and frequency of these least organizationally constrained attacks should covary.

The second class contains institutionally constrained weapons. This encompasses vehicle-borne improvised explosive devices, suicide vests, and other weapons whose use was strictly governed by the insurgent organizations. Unlike mobile weaponry, many of these are single-

[6] While these weapons can be used during highly coordinated offensive measures such as planned ambushes, their use was not restricted to such organizational engagements during these conflict.

use and reserved for highly planned operations in which the location and timing of the attack are determined in advance by senior combatants. While an individual combatant will ultimately exercise responsibility for the detonation, this discretion exists within narrow temporal and geographic bounds proscribed by operational planning. The simultaneous bombings of the United Nations' headquarters, Jordan's embassy, and Iraq's parliament were all perpetrated with such weapons (Roberts 2003; bbc 2003, 2007).[7]

If temperature influences insurgent violence by affecting only individual combatants, the frequency with which such organizationally constrained attack types are used should not vary with temperature, except perhaps through unmeasured covariates.

Hypothesis 1 *Frequency of attack types over which individual combatants exercise discretion varies with temperature; those subject to organizational constraints do not.*

3.1.2 Attack frequency by timing

The psychological literature provides a potential alternative explanation for an observed temperature-violence relationship in a conflict setting. The skeptical counter-point to observational studies of crime patterns is "routine activity theory" and emphasizes the potential for human interaction to turn violent when, as Rotton and Cohn (2000b) argue "contact appears to be a necessary [even if insufficient] condition for violence and aggression" (p. 652). Any observed correlation between temperature and wartime violence may therefore arise from a relationship between the behavior of insurgents' targets and ambient temperature.

Strategic interactions and incidental emotional effects are not exclusive, but they are empirically distinguishable. One of the strategic interaction explanation's implications is

[7] This class includes insurgent attacks like assassinations that are strategic even if the weapon is mobile.

that the relationship should exist for attacks on targets that move in response to ambient temperature.

Hypothesis 2 *Frequency of attacks against moving targets vary with temperature.*

A second approach exploits the timing of the insurgent attacks. Troops observing a population-centric counterinsurgency doctrine would seek contact with civilians in the light of day. If civilians were more likely to gather in public places in particular temperature ranges, counterinsurgents may be expected to have left their forward operating bases, becoming more vulnerable to attacks. However, nighttime counterinsurgent patrols in and around Baghdad are unlikely to be correlated with temperature. First, a nighttime curfew was in effect in Baghdad for the entire study period. Civilians found in violation risked their lives (Mansoor 2008). Because civilian movement was constrained, nighttime counterinsurgent patrols are unlikely to have varied with civilian movement. Second, supply convoys traveled at night, which accounted for much of the counterinsurgent's nighttime activities, did not vary their activities with temperature. The opposite was the case. The military directed convoys to "create irregular patterns"(ALSA 2014: p. 52).

Following the strategic interaction explanation, nighttime attacks would not vary with temperature because patrol movement is effectively held constant. However, nighttime temperatures vary across time and Iraqi insurgents remain active at night. If incidental emotions instead contribute to patterns of attack, we should observe variation in temperature at night and attacks using the least organizationally constrained weapons. This relationship should not exist for roadside bombs.

Hypothesis 3 *Frequency of organizationally unconstrained attacks varies with temperature at night.*

3.2 Insurgent Fatalities

Incidental emotions run subconsciously. At higher ambient temperatures, we expect insurgents' aggressive impulses to arise without conscious awareness. Their decisions to attack with–and only with–the least institutionally constrained weaponry at higher temperatures should generate greater costs. In particular, a more impulsive attack may be riskier to the individual insurgent.

Hypothesis 4 *Only attack types over which insurgents exercise individual autonomy are more likely to increase insurgent fatalities when carried out at higher ambient temperatures.*

3.3 Support for Violence

Individuals with the potential to produce violence should express levels of hostility that vary with their exposure to ambient temperature.[8]

Hypothesis 5 *Individuals' expressions of hostility vary with ambient temperature.*

4 Data Sources

We introduce our primary datasets here. The first addresses our measurements of insurgent violence, followed by the survey data to assess hostile attitudes, and concluding with temperature and other meteorological variables.

[8]Following the psychological literature, we expect this hypothesis to be true so long as fighters are unaware of temperature's effect on their emotional state.

4.1 Attack Frequency and Insurgent Fatalities

Three sources provide insurgent violence data. Throughout the Afghanistan and Iraq wars, international forces and their local partners maintained records of ”significant activities” (SIGACTs). These include attacks experienced or observed by international and/or local governmental forces. The latter includes, for example, insurgents targeting civilians. In our statistical testing, we use two distinct Iraq War SIGACTs datasets and one comprehensive SIGACTs dataset covering the Afghanistan War.

The three datasets share characteristics. All identify each attack's location within several meters, expressed in military grid reference system (MGRS) coordinates. Each set also includes the date and general category of attack. These include “direct fire,” “indirect fire,” and “improvised explosive device”. The datasets differ in other key respects central to our empirical testing. For the Iraq War, a limited set of SIGACTs data covering the period from February 2004 to February 2009 was originally obtained and released by Berman et al. (2011b) (release I). These data include details on the specific weapons type used in attacks carried out against international and Iraqi forces. For instance, an attack using a rocket-propelled grenade is identified as such, as well as being assigned to the more general classification of “direct fire”. Attacks using rifles and other small arms also qualify as direct fire.

In 2014, the Pentagon released its full dataset of Iraq war SIGACTs for this study. This second release covers the period from December 2003 through the end of December 2011, when American forces completed their withdrawal from Iraq (release II). This is the first public release of this dataset of 253,286 observations. Unfortunately, the more specific attack-type description is absent from the complete Iraq War dataset (release I). However, the second dataset has several variables absent from the first, including the actual time of insurgent attack.

For the Afghanistan conflict, Shaver and Wright (2016) secured and prepared the SIGACTs data. Unlike both Iraq SIGACTs datasets, this set includes details on attack outcomes, including whether it resulted in one or more fatalities to each party associated with each event. For instance, an IED that caused civilian and Afghan military deaths would separately indicate both outcomes. Although the data covers most years of the ongoing conflict, we conduct hypothesis tests on the period between January 2010 through October 2014, during which the International Security Assistance Force (ISAF) led by the United States consistently tracked these casualty figures.

We focus on two general classes of outcomes. The first involves attack frequency. It can measure the class of weapons used in the attack and the time of day when it occurred. The second class includes individual instances of insurgent casualties.

4.2 Iraqi Civilian Attitudes

The Independent Institute for Administration and Civil Society Studies (IIACSS), an Iraqi survey firm operating under U.S. military contract, surveyed civilian attitudes throughout the conflict. This initiative solicited responses from approximately 175,000 Baghdad residents across the city's ten neighborhoods (*mahalas*), themselves divided into the 467 blocks depicted in Figure 1. The firm collected information on respondent views and demographics, including their attitudes toward violence directed against multinational forces led by the United States. Klor et al. (2016) first introduced this data.

4.3 Meteorological Variables

The U.S. Government's National Climatic Data Center provides day- and hour-level time series datasets. They include ambient temperature and various meteorological covariates including visibility, wind speed, precipitation, dewpoint, and cloud cover collected by weather stations. We match individual station data to each of the cities and districts in the study.

Figure 1: Insurgent attacks plotted against IIACSS' survey blocks in Baghdad City

5 Empirical Testing Strategies

We conduct three general sets of statistical tests relating ambient temperature to 1) the frequency of insurgent violence, 2) insurgent fatality likelihood, and 3) the hostility of civilian attitudes.

Our overall research strategy establishes evidence in two distinct ways. First, we test whether a series of directly observable implications of incidental emotional effects find consistent support in the empirical results. The second relates to causal identification. The nature of the respective relationships between temperature and violence levels, insurgent fatality likelihood, and hostile attitudes precludes simultaneity, and causal interpretation is valid so long as no omitted variables bias our results. Because each of the three general sets of tests vary from one another in both context and units of analysis used, potential confounders from any given set are unlikely to apply to the others. For example, we have described the potential confounding influence of target movement, which might be correlated with temperature and insurgents' decision to attack.

In our second set of tests, we assess the likelihood that an insurgency suffers one or more fatalities at different temperature levels. For these tests, the decision to attack has already been made, holding constant all variables related to the choice to engage. Therefore, target movement should not affect fatality likelihood. Similarly, target movement is not a factor in the last set of tests associating daily temperature with hostility expressed by Iraqi males interviewed in their homes.

5.1 Temperature and Attack Frequency

The first set of tests associates temperature and insurgent violence during the Iraq War in three distinct ways. First, we analyze temperature's association with *attack types*. Because release I of the Iraq SIGACTs dataset includes specific attack types but not the precise time, we perform this analysis at the day level. We compare temperature's association with: the least organizationally constrained attacks, the most organizationally constrained attacks, and roadside bomb attacks.

Second follows a variation of this analysis at the hour level using data from SIGACTs release II. While release II includes only general categories of insurgent violence, we know from release I that direct fire attacks consisted overwhelmingly of small arms attacks. We therefore compare direct fire as a proxy for the least organizationally constrained attacks with roadside bomb attacks as a proxy for the most constrained. This has two benefits. First, in analyzing these relationships at the hour level, we associate temperature and insurgent violence at a temporal level that corresponds closely to the instantaneous influence of incidental emotion. Second, potential day-level confounders disappear at the hour level. This approach does not allow comparison between the least and most organizationally constrained attacks. For this reason, we conduct both sets of tests in the expectation they will estimate similar relationships between temperature and the outcomes of interest.

Finally, we associate temperature with direct fire and roadside bomb attacks at the hour level during only nighttime hours in Baghdad that were consistently covered by curfew. Qualitative evidence suggests that civilian travel during this period was effectively fixed and that military movement was more likely to be randomized than during the day. This serves as an additional robustness check against the possibility that target movement is influencing test results.

5.1.1 Day-Level Analysis

To estimate a relationship between temperature and insurgent violence by type, we construct two independent time series for the Iraqi cities of Baghdad and Basrah.[9] We select these two

[9]For each city, we construct the longest time series possible given data availability. For Baghdad, the time series covers the period from 2005-01-01 to 2009-02-24. For Basrah, this period runs from 2004-02-04

cities because the greatest number of relevant controls were available for them. Together, they capture approximately 42% of all recorded insurgent attacks during the war.

Because insurgent attacks are measured in counts, we separately use poisson, quasi-poisson and negative binomial regression models to generate associations between the variables of interest. Our primary estimating equation is:

$$E(Y_{t,i}| \sum_{j=1}^{n} Y_{t-j,i}, D_{t,i}, V_{t,i}) = e^{(\sum_{j=1}^{n} \varphi_j Y_{t-j,i} + \beta D_{t,i} + \gamma D_{t,i}^2 + \xi V_{t,i} + \phi_v)},$$

where t, v, and i denote days $\{1, \ldots, m\}$, weeks $\{1, \ldots, n\}$, and cities $\{1, \ldots, p\}$, respectively. The least organizationally constrained attacks are denoted by $Y_{t,i}$, and daily mean temperatures are given by $D_{t,i}$.

This non-monotonic model allows for diminishing returns to temperature, which establishes the existence and functional form of a temperature-attack frequency relationship. Temperature is serially correlated. To account for the possible influence of correlation between previous temperature values and that of present violence, the vector $\sum_{j=1}^{m^*} \beta_j D_{t-j,i}$ is included in the model. Similar logic applies to previous violence values, which may affect the levels of violence insurgents produce in the present period. The vector $\sum_{j=1}^{m^*} \alpha_j Y_{t-j,i}$ captures this. The value m^* is selected from possible lag lengths m that minimizes the Bayesian information criterion score. Week fixed effects minimize any omitted variable bias that the controls themselves do not eliminate.

Finally, the vector $V_{t,i}$ contains time-variant city-level control variables:

Additional Insurgent Violence Types: Other types of insurgent violence like indirect fire and IED attacks are likely to be correlated with small arms attacks and possibly with temperature. Their inclusion controls for all other types of violence. We also include vectors of each of these variables lagged, once again for the period that minimizes the Bayesian information criterion score.

through 2008-02-17. Both series cover the period of most intense fighting during the war.

Hours of Daylight: Longer days are warmer. We include daily daylight hours in the model to account for the possibility that more attacks occur in warmer weather because greater numbers of daylight hours affect insurgents' opportunity to attack (Astronomical Applications Department).

Meteorological Conditions: Weather patterns related to temperature may influence some insurgent tactics. For instance, sandstorms reportedly provided cover to insurgents firing rockets and mortars against international positions in Baghdad (Samuels 2008). Vector $V_{t,i}$ therefore includes data on visibility, wind speed, maximum wind speed, precipitation, and dew point.[10]

Hours of Power: Temperatures in Baghdad and Basrah reach extreme highs. During the study period, they extended into the 120s°F. As temperatures increased, especially at such high levels, electricity demand for cooling is likely to have grown concurrently. Electricity supply was irregular. Community dissatisfaction with the government's inability to supply electricity, particularly during warmer periods when most needed, may have facilitated an increase in insurgent attacks through two mechanisms. First by diminishing the willingness of civilians to share intelligence about insurgents with Iraqi and international forces; second by increasing their motivation to take part in the insurgency. To address this possibility, we control for the number of hours of power supplied per day (Shaver and Tenorio 2015).

Seasonal Factors: Early findings associating ambient temperatures with violent crime levels were initially challenged because seasonal factors might account for statistical results: "temperatures are highly related to seasonal events such as vacation time, students being out of school, and alcohol consumption, events that might influence crime rates" (Anderson 1987). While patterns of alcohol consumption are not relevant to patterns of insurgency in

[10]These variables are defined: visibility: 'mean visibility for the day in miles to tenths"; wind speed: "[m]ean wind speed for the day in knots to tenths"); maximum wind speed: "[m]aximum sustained wind speed reported for the day in knots to tenths"; precipitation: total "rain and/or melted snow... reported during the day in inches and hundredths"; and dew point: "[m]ean dew point for the day in degrees Fahrenheit to tenths" (National Climatic Data Center; Manual).

predominately Muslim Iraq, whether schools are in session may be one such confounding factor. Evidence from modern insurgencies suggests that students in recess are sometimes recruited (O'Connell and Benard 2006; Ki-moon et al. 2013). The model's week fixed effects generate estimates through within-week comparisons, effectively controlling for any remaining potential seasonal factors.

Next, we replicate this exercise, first for the most organizationally constrained violence, then for roadside bomb attacks as the outcomes of interest. If temperature affects insurgent violence by influencing combatants' aggressive impulses, there should be little to no effect of temperature on organizationally constrained attacks. And if a relationship between temperature and violence is driven by target movement, it should manifest in a clear correlation.

Mean expected counts of insurgent violence for the range of annual average temperatures observed in the study data[11] are calculated as follows: $\mu = 1/n \sum_{i=1}^{n}(e^{(X_{t,i}^{T}\phi)}) \; \forall \; d \in$ [5°C and 50°C], where $X_{t,i}^{T}\phi = \varphi Y_{t-j,i} + \beta D_{t,i} + \xi V_{t,i} + \phi_v$. We generate confidence intervals at the 95% significance level with a quasi-Bayesian Monte Carlo simulation. As a robustness check, we use ordinary least squares regression to estimate these relationships with an autoregressive model.[12]

5.1.2 Hour-Level Analysis

Time-stamped data from SIGACTs release II allows hour-level analysis. We study nearly every moment of the Iraq War in Baghdad, analyzing every hour of the period between

[11]To ensure that rarely observed temperature values do not skew the findings, we generate results with and without these most extreme values. There is no meaningful difference between them.

[12]Specifically, we test the following equation $Y_{t,i} = \vartheta D_{t,i} + \varphi D_{t,i}^2 + \sum_{j=1}^{m^*}(\alpha_j Y_{t-j,i} + \beta_j D_{t-j,i}) + \varrho' V_{t,i} + \upsilon_v + e_{t,i}$. In the OLS specification, we log per capita insurgent attacks. Because many observations take a value of 0, we log the per capita incidents after adding one to the variable. While the distributions of incidents of insurgent violence and per capita incidents of insurgent violence are both positively skewed, that of logged per capita attacks is less so. It is therefore used in the primary specification. Finally, to account for possible remaining serial correlation among the residuals, standard errors presented are both heteroskedasticity and autocorrelation consistent.

January 1, 2005 and December 31, 2011, the day on which U.S. forces formally exited from the country.

Temperature affects aggression quickly. Adopting the hour as the unit of analysis allows testing for near-immediate associations between temperature and violence. The approach also excludes the biasing influence of potential unobserved confounders at the day-level analysis. As with the day-level analysis, we test the following non-monotonic equation using count models: $E(Y^t_h | \sum_{j=0}^{23}(Y_{h-j}, D_h, M'_h)) = e^{(\sum_{j=0}^{23}(\alpha_j Y_{h-j} + \vartheta_j D_h + \beta_j M'_h) + \upsilon_d)}$, where h and d denote hour of the day and date, respectively.[13] Insurgent violence is given by Y, where t denotes violence type: direct fire and roadside bomb attacks. D denotes hourly temperature. M is a vector of those meteorological variables collected by weather stations at the hour level: wind speed, visibility, dew point, and sky cover.[14]

We include lagged vectors for each hour of the past twenty-four hours of each variable to account for the possible influence of correlation between previous temperature, meteorological, and violence values and that of present violence. Finally, we include time-of-day and week fixed effects so that inferences are drawn by comparing variation in temperature and violence that occurs within a single week at a particular hour of the day.

5.1.3 Hour-Level Nighttime Analysis

A narrower testing strategy involves assessing whether the hypothesized temperature-direct fire relationship manifests at the hour-level during nighttime curfew period in Baghdad when civilian movements that might otherwise affect insurgent targeting are effectively held constant.

[13]At the hour level, observations most frequently assume values of 0 and 1. Therefore, we also replicate this analysis using logistic regression as a robustness check. We create a binary attack variable, which assumes a value of 1 if one or more attacks occurred on a given hour and 0 otherwise.

[14]Defined: wind speed: "wind speed in miles per hour"; visibility: "visibility in statute miles to nearest tenth"; dew point: "dew point in Fahrenheit"; and sky cover: a factor variable that indicates whether on a given hour sky cover is "clear", "scattered", "broken", "overcast", "obscured", or partially obscured.

In this test, we also compare temperature's association with IED attacks. If target movement is a function of temperature at nighttime, a relationship between these variables should emerge. We use the same estimating equations described above and use count models, and logistic regression with the appropriately transformed outcome variables. Based on the curfew hours imposed throughout the war, we restrict our sample to the hours between 11:00 p.m. and 5:00 a.m.[15]

5.2 Temperature and Insurgent Fatalities

Are insurgent attacks carried out at higher temperatures tactically disadvantageous to the perpetrator? The second set of statistical tests associate temperature and insurgent fatalities during the Afghanistan War. We associate temperature on the day of an attack with whether one or more of the insurgents died in the process of carrying out a given direct fire attack.

Logistic regression tests the estimating equation presented in the preceding day-level analysis, with key modifications. First, individual insurgent direct fire attacks become the unit of analysis. Second, the outcome variable with an indicator of whether one or more insurgent fatalities resulted during an insurgent attack.

Observations are drawn from Afghanistan's fifteen most violent districts, which account for approximately half of all ISAF-documented insurgent attacks that have occurred in the country during the ongoing conflict.[16]

Rather than aggregating to the district level, adopting the insurgent attack as the unit of analysis avoids estimating a mechanical correlation between temperature and fatality incidence that would occur simply because there is more insurgent violence at higher temperatures. Instead, under this approach, there is no need to control for quantity of violence.

[15]Although curfew hours varied during the conflict, this range was consistently covered according to a variety of press reports.

[16]We limit observations to these districts because temperature data is not available for the entire country.

We then replicate this test, adopting individual insurgent roadside bomb attacks as the unit of analysis for two purposes. First, a placebo check. Roadside bomb attacks are resistant to impulsive aggression because these weapons are only effective when targets are proximate. There should therefore be no relationship between temperature and roadside bomb fatalities. Second, it addresses possibly confounding links between the physiological likelihood of death and higher temperatures. For instance, a relationship between insurgent fatalities and temperature might be driven by insurgents being less effective in staunching blood loss at higher temperatures. If such a relationship exists, it should manifest with respect to roadside bomb attacks as well. The absence of a relationship between temperature and IED fatality likelihood would rule out this alternative explanation.

5.3 Temperature and Aggressive Civilian Attitudes

The final set of tests associates temperature and the expressed hostile attitudes of Iraqi males surveyed throughout the war. They provide a direct test of the incidental emotion effect.

If changes in perpetrator aggression drive changes in temperature's effect on violence, a corresponding relationship between ambient temperature and this variable should also be observed. The detailed IIACSS survey data provides an opportunity to test this expectation. In particular, we expect that when indicating whether they support violent attacks on American forces, respondents are more likely to answer in the affirmative at higher ambient temperatures.

Using logistic regression to generate an association between Baghdad's recorded daily high temperature and citizen support for violent attacks on international forces in the country, we test: $P(Y_i = 1|T_j, S_i) = logit^{-1}(\alpha_i + \beta_1 T_{t,i} + \beta_1 T^2_{t,i} + \gamma Z_i + \psi V_{j_i,k_i} + \rho_{j_i} + \upsilon_{k_i})$.

Because we seek to assess the effect of temperature on aggressive ideation in individuals most representative of combatants, we let i represent male respondents $\{1, \ldots, p\}$ of fighting age. j and k denote Baghdad neighborhoods $\{1, \ldots, q\}$ and month of response $\{1, \ldots, r\}$, respectively.[17] $Y_{t,i}$ is a binary indicator assigned a value of 1 for respondents who answer affirmatively the question "Do you support attacks against: Multi-National Forces?" and a value of 0 otherwise.[18] Daily temperature high is denoted $T_k \in \mathbb{R}$. Z_i is a vector of individual respondent controls and include each respondent's reported income, education level, age, and household size. Neighborhood fixed effects control for time-invariant characteristics specific to each neighborhood. Similarly, by absorbing across-time variation, month-of-response indicators reduce potential bias by deriving estimates of interest on the basis of within-month date variation.

Predicted probabilities of support for attacks on international forces for the range of temperatures observed within the study data are calculated $\mu = 1/n \sum_{i=1}^{n}$ $(e^{(X_i^T \phi)} / (e^{(X_i^T \phi)} + 1))$ $\forall$ temperature $h \in [50$ and $116]$. Quasi-Bayesian Monte Carlo simulation generate confidence intervals at the 95% significance level.

A second test verifies the results. Although survey respondents were interviewed in their homes, the unavailability of electricity throughout the Iraq War ensures that for most respondents, daily measures of ambient temperature closely approximate actual temperature levels to which individuals were exposed during interviews. However, wealthier citizens were more likely to have access to private generators and fuel with which to power fans or air-conditioners. If including wealthy citizens in the original sample attenuated the results because they were not subject to the ambient temperature treatment, we expect intensified

[17] Month fixed effects are used instead of week fixed effects. Surveys were carried out during fixed periods during each month, leaving limited comparable within-week variation in responses. Nevertheless, estimates on temperature and temperature squared in a week fixed effects model are statistically significant at the 99% level.

[18] Although direct questions on sensitive topics can elicit biased responses, that is not a concern in this case. First, over half of participants provided a direct answer despite a "Don't Know" answer. Therefore, there is no indication that respondents sought to avoid answering this question. Second, although American forces financed the initiative, IIACSS' Iraqi enumerators introduced themselves to respondents as unaffiliated researchers, which should have eased concern over the destination of the survey data. Finally, even if respondents feared answering this question because of possible retaliation by international/federal government forces or insurgents, this should result in a shift in the baseline response but not in changes in response to temperature level.

results after excluding those who report the highest income levels.

Because coefficients in generalized linear models may be biased by including fixed effects, we also test the equivalent linear probability models, clustering standard errors at the neighborhood. More stringent tests in which in which survey block and week fixed effects are substituted for neighborhood and month fixed effects produce consistent results.

6 Results

Insurgent violence was widespread across Baghdad and Basrah during the day-level study period. Together, these cities experienced 55,851 major insurgent attacks (including 21,862 direct fire and 21,767 IED attacks). The fifteen most violent Afghan districts in the study experienced 44,172 direct fire and 11,927 IED attacks. Of the 44,284 combat-age male survey respondents who provided responses to all relevant questions included in our analysis, nearly 60% expressed support for violence against multinational forces.

Temperatures varied over the various study periods and locations. In Baghdad, mean daily temperatures spanned 36.50°F to 106.50°F, with a mean of 75.25°F. Hour-level temperatures ranged from 28°F to 124°F, with a mean of 76.62°F. Finally, across all survey days in Baghdad, temperature minimum, maximum, and mean values were 42.70°F, 79.00°F, and 103.20°F, respectively. In Basrah, mean daily temperatures were slightly higher, ranging from 40.20°F to 104.40°F with a mean of 77.94°F. In Afghanistan, temperatures were cooler. Across all fifteen districts, temperatures reached a low of 12.10°F, a high of 106.00°F, and had a mean of 74.28°F.

The statistical tests find that ambient temperature affects: 1) the production of the least organizationally constrained violence during conflict, 2) the likelihood that insurgents perish when carrying out direct fire attacks; and 3) the likelihood that surveyed Iraqi males express support for violence against multinational forces. The three sets of results are consistent with the hypothesis that temperature's effect on violence is positive but diminishes at particularly high temperatures. The relationship between temperature and all three outcomes share near-identical estimated functional forms. Finally, the magnitudes of the estimated effects are substantial. Taken together, these test results demonstrate that temperature's effects on aggressive impulse are not only identifiable but give rise to meaningful changes in key wartime outcomes.

6.1 Attack Frequency

Mean daily temperature and small arms fire are positively correlated for all temperature values below 83°F. The relationship turns negative above that temperature. The hour-level analysis is consistent with this result and estimates that direct fire attacks peak between 91°F in the logistic regression estimate and 100°F in the count model.

As expected, we observe no statistically significant relationship between mean daily temperature and the most organizationally constrained insurgent violence. In the day-level analysis, there is no statistically significant relationship in temperature and roadside bomb attacks. Hour-level results suggest that roadside bomb attacks consistently decrease in temperature for all values above 70°F. These results provide clear support that the observed relationships between small arms and, separately, direct fire attacks and temperature are not driven by target movement. Indeed, to the extent that the least organizationally constrained attacks are influenced by target movement, results suggest that target movement biases the results downward. Hour-level nighttime results are consistent with these results – direct fire attacks are estimated to increase with nighttime temperature while roadside bomb attacks decrease. Finally, results are robust across all count, ordinary least squares, and logistic regression models. Regression results are reported in tables 1, 2, and 3. Graphically, mean attack counts and predicted probabilities of attacks are presented in figures 2 and 3.

Substantively, the results suggest that ambient temperature's effect on insurgent violence

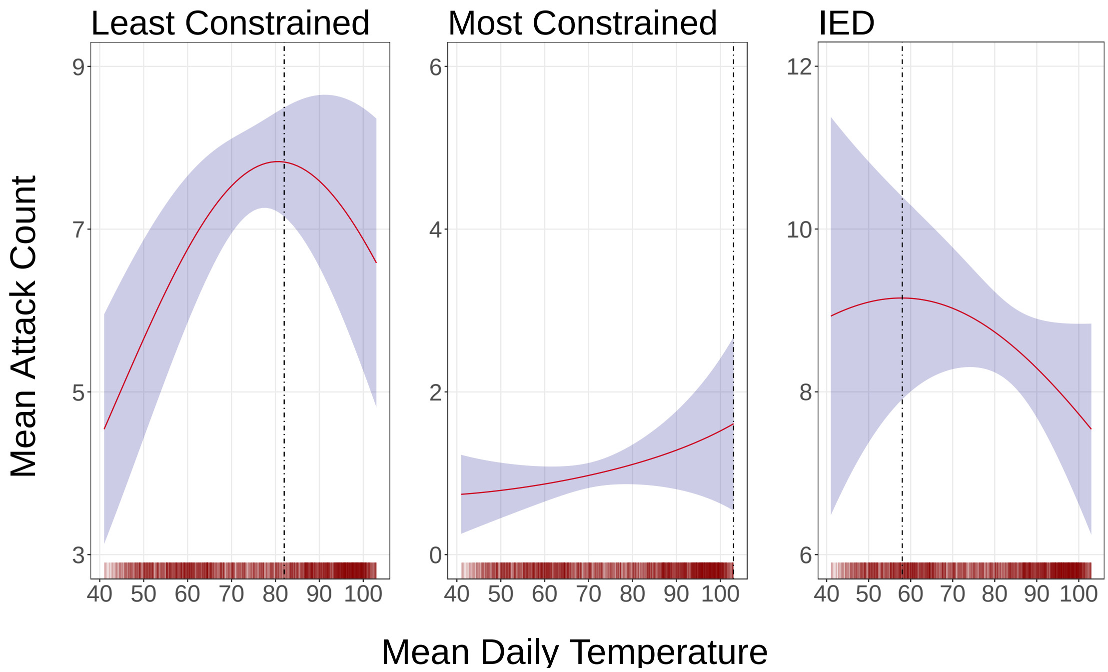

Figure 2: This figure contrasts estimated mean attack counts across types of insurgent violence as a function of mean daily temperatures in Baghdad and Basrah using data for most days of the Iraq War (with 95% Confidence Intervals). Consistent with findings from criminology and psychology, the least organizationally constrained attacks, those primarily involving pistols and rifles over which individual combatants exercise the greatest discretion, tend to increase in temperature, then turn negative beyond a certain threshold. The most organizationally constrained attacks–for instance, car and suicide bombings–show little relationship with temperature. The absence of a positive relationship between mean daily temperature and IEDs, directed almost exclusively against moving targets, provides strong evidence that a general positive relationship between temperature and violence is not driven by movement in the target.

is significant. For instance, drawing from the hour-level results, moving from a temperature of 60°F to 100°F is associated with a more than 30% increase in the number of direct fire attacks.

6.2 Insurgent Fatalities

Insurgents choosing to engage ISAF and/or Afghan government forces in direct fire combat at higher temperatures were more likely to die than those who did so at cooler temperatures.

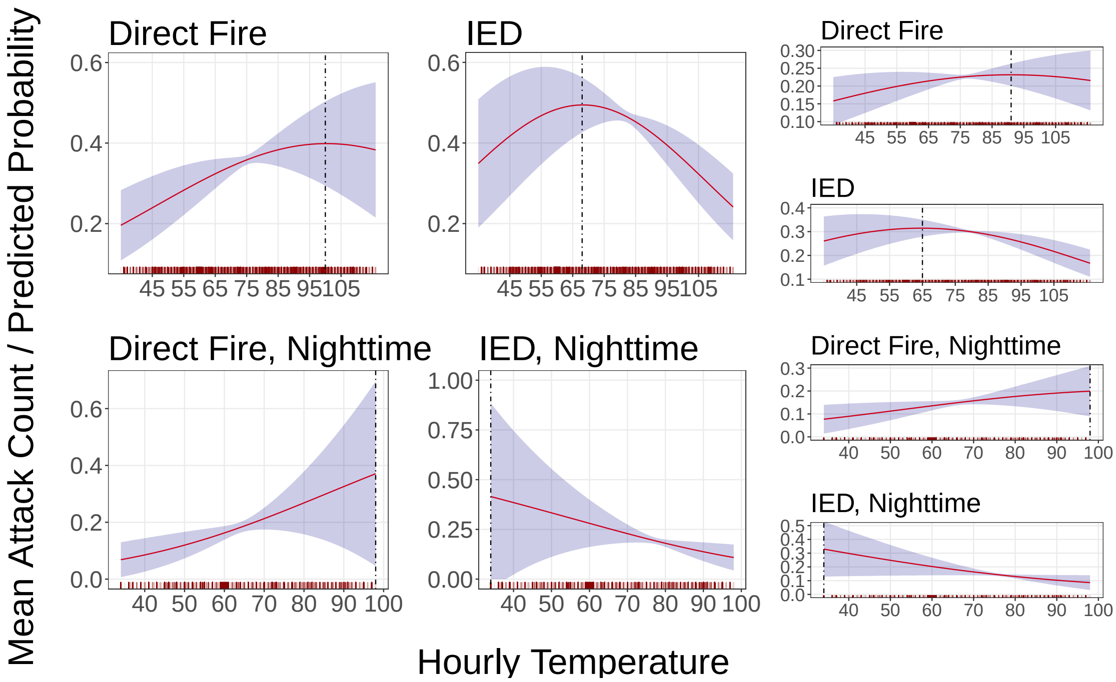

Figure 3: This figure contrasts the association between hour-level temperature and direct fire and, separately, IED attacks in Baghdad using data for nearly every hour of the Iraq War (with 95% Confidence Intervals). The upper left image shows that temperature is generally linearly associated with direct fire attacks, which consist primarily of attacks carried out with weapons over which combatants exercise the greatest discretion over timing. The upper middle image reveals this relationship for IED attacks. The absence of a positive relationship between hourly temperature and IED attacks provides strong evidence that a general positive relationship between temperature and violence is not driven by movement in the target. The bottom left and center images depict these same relationships using only data from nighttime curfew hours. Finally, the four smaller images in the right column summarize these same relationships expressed in the predicted probability of attack when estimated with logistic regression.

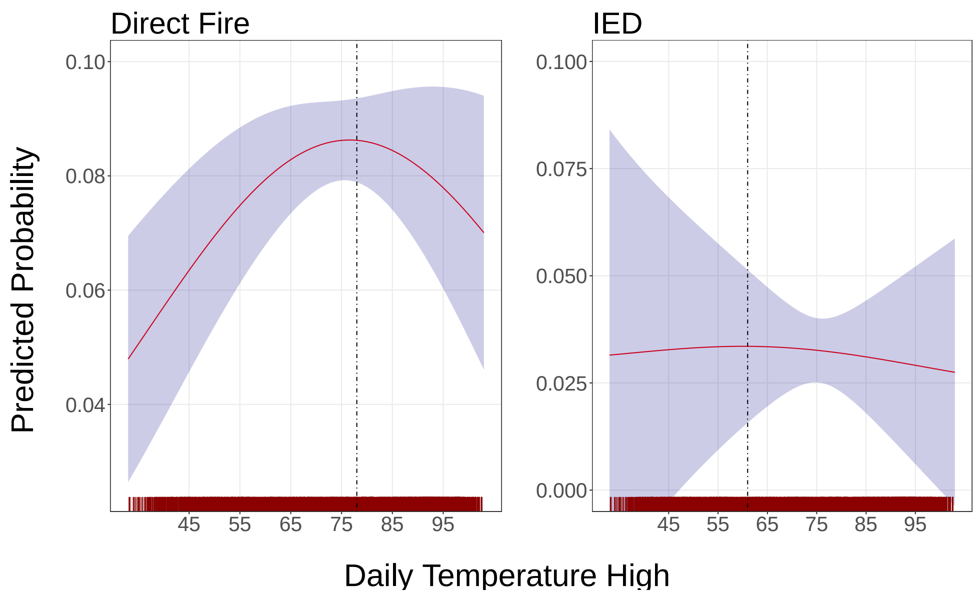

Figure 4: This figure contrasts the predicted probability that insurgents suffered at least one fatality when carrying out direct fire (left) and IED attacks (right) as a function of mean daily temperatures in Afghanistan's fifteen most deadly districts during the five year period of most intense fighting during the ongoing Afghanistan conflict (with 95% Confidence Intervals). The image on the left reveals that insurgents were more likely to sustain fatalities when carrying out direct fire attacks at higher temperatures. No such relationship is observed with IED attacks.

Consistent with the daily and hourly level insurgent violence results, this relationship reverses beyond a mean daily temperature just below 80°F. This relationship does not exist for IED attacks, for which the predicted probability of insurgent fatalities is constant across temperatures and statistically insignificant.

In moving from the coolest mean daily temperatures to those around 80°F, the predicted probability of insurgents suffering at least one fatality for a given direct fire attack increases by approximately 4 percentage points. In Afghanistan, where ISAF forces have documented approximately 50,000 incidents of direct fire attacks during the ongoing conflict, this relationship suggests that a substantial number of Taliban fighters are likely to have been affected. This finding provides a distinct piece of evidence consistent with a direct psychological effect of temperature on conflict. Results are reported in table 4 and figure 4.

6.3 Hostile Attitudes

In Iraq, mean daily temperature and support for the use of violence against international forces are positively associated. Consistent with the other results, attack support diminishes above the mean daily temperature of 85°F. As expected, this relationship is dependent upon income level. When all fighting-age male respondents are included, the statistical and scientific magnitudes attenuate. The results are more pronounced when excluding those most likely to have access to air-conditioning units or fans: the top-earning quarter of respondents. The effect of temperature disappears entirely in an analysis of only these top income earners.

In moving from the coolest mean daily temperatures to around 85°F, the predicted probability of an Iraqi male expressing support for violence against multinational forces increases by percentage points somewhere between 10 in the full sample results and 15 when excluding respondents most likely to have access to cooling technologies. These results are reported in tables 5 and figure 5.

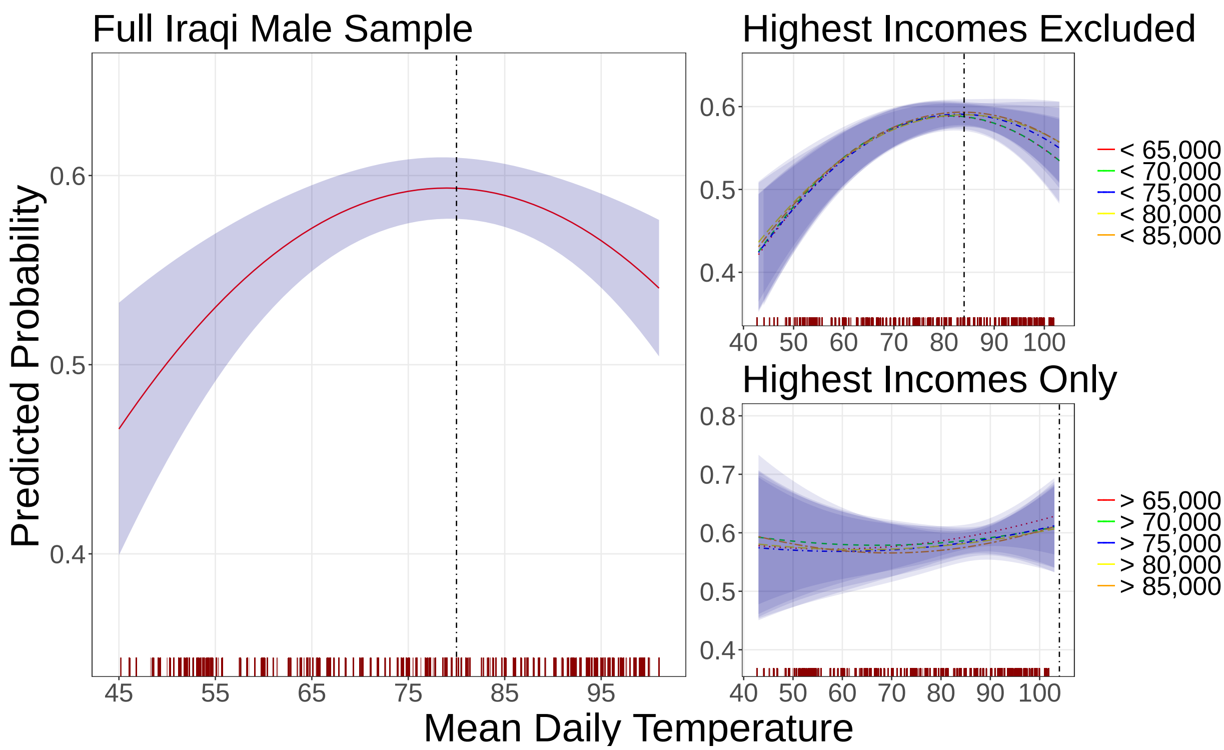

Figure 5: This figure depicts the predicted probability of expressed support for violent attacks on multinational forces by combat-age Iraqi males surveyed throughout the recent Iraq War as a function of mean daily temperature (with 95% Confidence Intervals). The image on the left includes all 44,284 male respondents and shows that expressed hostility toward American and other international forces increased predictably with temperature. Consistent with a psychological explanation for this phenomenon, the upper right image shows that this relationship intensifies when respondents most likely to have had access to cooling technologies in their homes during the interview are excluded from the sample (the top quartile of income earners). In contrast, as the bottom right-hand image depicts, when only these top income earners were included in the statistical analysis, temperature's relationship with expressed support for violence disappears.

6.4 Scope

Assuming that entry into an insurgent organization requires more than 24 hours, the study's design allows us to draw inferences about the *intensive* margins of violence as a function of daily temperature. We measure changes in the frequency of attacks carried out by a fixed number of insurgents willing and able to commit violence against their adversary.[19] Our study is not related to the recruitment of new fighters to violent organizations or previously peaceful groupings opting for violent tactics. That is, we do not not measure *extensive* marginal effects.

The case-specific nature of the data raises questions relating to the external validity of these findings. The events recorded in the database reflect the actions of an insurgency in a highly asymmetric contest with counterinsurgent forces. If anything, we would expect temperature's effect on insurgent violence to be less pronounced in such asymmetric situations, where counterinsurgents with access to airpower, heavily armored vehicles, and precise artillery may force insurgents to adopt a greater level of discipline than they otherwise would in more symmetric conflicts. Furthermore, Iraq's major urban settings serve as a hard test: that such results obtain in a setting with relatively high average daily ambient temperatures and are nevertheless consistent with findings connecting temperature and violent crime in areas where such temperatures are much lower suggests that the theorized phenomenon is not an artifact of particular settings. It is a consistent feature of anthropogenic violence.

As with the observational psychological research that established the temperature-violence connection, we also test the wartime relationship in urban settings in Iraq and Afghanistan. Rural combat dynamics may vary, making it difficult to control for the possibility of a tactical incentive to adjust attack patterns to ambient temperature.

[19] An individual can carry out an attack without organizational support, but the odds of operational success are smaller.

6.5 Implications

In conflict settings, some emotional stimuli acting on the combatants may make violent behavior more likely, while others may diminish this likelihood. Together, emotional factors enhancing or inhibiting propensity for violence combine with strategic factors doing the same, culminating in the observed violent act – or the unobserved restraint. These individual-level effects then aggregate to determine the type and frequency of violence in a war. This could set the course of conflict by influencing the likelihood of escalation and contagion of conflict or by reshaping affected actors' preferences. The magnitude of the effect challenges the view that "individual motivations alone are unlikely to result in large-scale violence over a long period" (Kalyvas et al. 2006: p. 26).

The findings about short-term motivations for violence provides micro-foundational evidence for the observed long-term link between particular climates and violence. Incorporating the results of 60 prior studies, Hsiang et al. (2013) find that "for each 1 standard deviation (1σ) change in climate toward warmer temperatures or more extreme rainfall, median estimates indicate that the frequency of interpersonal violence rises 4% and the frequency of intergroup conflict rises 14%" (p. 1). This line of inquiry frequently assumes that the effect works through temperature's economic consequences, especially agriculture. The empirical finding that sub-state violence retains its association with temperature in non-agricultural areas combine to suggest that past conflict research may focus too narrowly on long-term, large-scale mechanisms (Bollfrass and Shaver 2015). Instead, our findings propose that an observed temperature-conflict correlation in non-agricultural areas of the world partly reflect aggregate and emergent patterns of incidental emotional violence and might be incorporated in future models predicting the economic, political, and social effects of a changing climate.

7 Conclusion

Elevated ambient temperatures induce more aggressive behavior in vehicles, homes, bars, and in the streets. We have demonstrated that this emotional effect persists when individuals are placed in an organized group conflict setting. In datasets of Afghan and Iraqi insurgent attacks on international counterinsurgent forces, attacks whose initiation is in the hands of individual insurgents are strongly correlated with ambient temperatures. Afghan insurgents also suffered higher rates of fatality during these attacks. Attack types subject to greater organizational deliberation and control do not share this correlation. Iraqi military-age males reported higher support for violence at elevated temperature ranges.

The statistically and substantively large contribution of a purely incidental emotion to political violence addresses a core assumption of scholarship on civil war, insurgency, and ethnic violence. Instead of assuming that any observed violence is strategic in nature, the conditions under which violence manifests can be better understood if strategic and emotional motivations are seen to combine to create violent outcomes.

Temperature is not the sole emotional contributor to acts of violence and may be responsible for a relatively small amount of wartime violence by itself. The key conclusion is that these findings supply evidence that other emotional stimuli far more integral to conflict than ambient temperature shape the type and frequency of political violence. These remain difficult to measure in observational settings, but we hope our results encourage further investigation and provide cause for caution in assuming that observed acts of violence in political settings arise from higher strategic aims.

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Table 1: Mean daily temperature on 1) the least and 2) most organizationally constrained insurgent attacks and 3) improvised explosive device (IED) attacks during most years of the recent Iraq War. Data from Baghdad and Basrah.

	Negative Binomial			**Poisson**			**Quasipoisson**			**OLS**		
	Unconstrained	Constrained	IED	Unconstrained	Constrained	IED	Unconstrained	Constrained	IED	Unconstrained (log, pc)	Constrained (log, pc)	IED (log, pc)
Temperature	**0.074*****	**−0.061**	**0.012**	**0.067*****	**−0.045**	**0.012**	**0.067*****	**−0.045**	**0.012**	**0.047*****	**−0.021**	**−0.003**
	(0.017)	(0.039)	(0.013)	(0.014)	(0.037)	(0.013)	(0.017)	(0.043)	(0.015)	(0.014)	(0.013)	(0.012)
Temperature (Squared)	**−0.0005*****	**0.001****	**−0.0001**	**−0.0004*****	**0.0005***	**−0.0001**	**−0.0004*****	**0.0005***	**−0.0001**	**−0.0003*****	**0.0002****	**−0.00003**
	(0.0001)	(0.0003)	(0.0001)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	−8.043***	−4.201	−2.055	−8.006***	−1.798	−1.864	−8.006***	−1.798	−1.864	−3.775***	0.639	−5.489***
	(1.953)	(17,150.890)	(1.466)	(1.719)	(3,467.861)	(1.424)	(2.070)	(4,051.237)	(1.700)	(1.268)	(1.219)	(1.129)
City Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Week Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Meteorological Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Hours of Electricity Control	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Other Violence Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Temperature	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Violence (outcome)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Violence (other types)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2,348	2,348	2,348	2,348	2,348	2,348	2,348	2,348	2,348	2,348	2,348	2,348
R^2										0.869	0.587	0.912
Adjusted R^2										0.854	0.540	0.902

Note: *p<0.1; **p<0.05; ***p<0.01

Table 2: Hourly temperature on direct fire (DF) and improvised explosive device (IED) attacks during the Iraq War. Data from Baghdad and cover every hour of nearly every day of the entire war period.

	Negative Binomial		**Poisson**		**Quasipoisson**		**Logit**	
	DF	IED	DF	IED	DF	IED	DF (binary)	IED (binary)
Temperature	**0.040*****	**0.047*****	**0.040*****	**0.046*****	**0.040*****	**0.046*****	**0.047*****	**0.056*****
	(0.008)	(0.007)	(0.007)	(0.006)	(0.008)	(0.007)	(0.011)	(0.010)
Temperature (Squared)	**−0.0002*****	**−0.0003*****	**−0.0002*****	**−0.0003*****	**−0.0002*****	**−0.0003*****	**−0.0002*****	**−0.0004*****
	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.00003)	(0.0001)	(0.00005)
Constant	−2.630***	−3.241***	−2.614***	−3.220***	−2.614***	−3.220***	−2.860***	−3.695***
	(0.285)	(0.258)	(0.268)	(0.242)	(0.286)	(0.260)	(0.406)	(0.372)
City Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Week Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Meteorological Controls	Y	Y	Y	Y	Y	Y	Y	Y
Hours of Electricity Control	Y	Y	Y	Y	Y	Y	Y	Y
Other Violence Controls	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Temperature	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Violence (outcome)	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Violence (other types)	Y	Y	Y	Y	Y	Y	Y	Y
Observations	58,779	58,779	58,779	58,779	58,779	58,779	58,779	58,779

Note: *p<0.1; **p<0.05; ***p<0.01

Table 3: Hourly temperature on nighttime direct fire (DF) and improvised explosive device (IED) attacks during the Iraq War. Data from Baghdad and cover every hour of nearly every day of the entire war period. Hours of coverage include those from 11:00 p.m through 5:00 a.m., the period consistently covered by curfew during the war.

	Negative Binomial		**Poisson**		**Quasipoisson**		**Logit**	
	DF	IED	DF	IED	DF	IED	DF (binary)	IED (binary)
Temperature	**0.090*****	**−0.031**	**0.090*****	**−0.030**	**0.090*****	**−0.030**	**0.086****	**−0.064***
	(0.028)	(0.030)	(0.027)	(0.029)	(0.027)	(0.029)	(0.035)	(0.037)
Temperature (Squared)	**−0.0004****	**0.0001**	**−0.0005*****	**0.0001**	**−0.0005*****	**0.0001**	**−0.0004***	**0.0001**
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Constant	−4.955***	−3.843***	−5.034***	−3.820***	−5.034***	−3.820***	−4.744***	−3.257**
	(0.943)	(1.327)	(0.915)	(1.310)	(0.924)	(1.327)	(1.134)	(1.478)
City Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Week Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y
Meteorological Controls	Y	Y	Y	Y	Y	Y	Y	Y
Hours of Electricity Control	Y	Y	Y	Y	Y	Y	Y	Y
Other Violence Controls	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Temperature	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Violence (outcome)	Y	Y	Y	Y	Y	Y	Y	Y
Vector of Lagged Violence (other types)	Y	Y	Y	Y	Y	Y	Y	Y
Observations	17,174	17,174	17,174	17,174	17,174	17,174	17,174	17,174

Note: *p<0.1; **p<0.05; ***p<0.01

Table 4: Mean daily temperature on insurgent fatalities sustained by Taliban fighters in Afghanistan during 1) direct fire (DF) and 2) improvised explosive device (IED) attacks. Data are from Afghanistan's fifteen most violent districts between the years of 2010 and 2014.

	DF	IED
Temperature	**0.074*****	**0.046**
	(0.021)	(0.037)
Temperature (Squared)	**−0.056**	**−0.000**
	(0.336)	(0.000)
Constant	−15.681	−51.475
	(790.865)	(21,241.410)
District Fixed Effects	Y	Y
Week Fixed Effects	Y	Y
Time-of-Day Fixed Effects	Y	Y
Meteorological Controls	Y	Y
Other Fatality Controls	Y	Y
Observations	33,923	9,602
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 5: Mean daily temperature on combat-age Iraqi males' expressed support for the use of violence against American and other international forces during the Iraq War. Data were collected from 44,284 men during surveys carried out during most months of the Iraq War.

	Full Iraqi Male Sample	Top Income-Earners Excluded	Top Income-Earners Only
Temperature	**0.087*****	**0.119*****	**−0.009**
	(0.020)	(0.023)	(0.046)
Temperature (Squared)	**0.003*****	**0.005*****	**−0.002***
	(0.001)	(0.001)	(0.001)
Insurgent Violence (Past Week Average)	0.0002	0.002**	−0.004***
	(0.001)	(0.001)	(0.001)
Constant	−1.338*	−2.557***	2.001
	(0.689)	(0.793)	(1.572)
Neighborhood Fixed Effects	Y	Y	Y
Month Fixed Effects	Y	Y	Y
Meteorological Controls	Y	Y	Y
Demographic Controls	Y	Y	Y
Education Control	Y	Y	Y
Observations	32,502	23,952	7,451

Note: *p<0.1; **p<0.05; ***p<0.01